Trading Bases:
Resolving the Guns vs. Butter Tradeoff Puzzle via Full Specification

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Abstract

Investigations of the 'guns vs. butter' trade-off models of military spending have yielded surprisingly inauspicious results in spite of the intuitively appealing nature of the hypothesis that the more we spend on defense the less we can spend on social welfare, etc. This paper examines the standard specification of the tradeoff model and demonstrates that the lack of empirical success of this hypothesis has been largely a problem of model specification. The first part of the paper offers both mathematical proof and empirical confirmation of the nature of this misspecification. The balance of the argument then outlines how proper specification clarifies the appropriate means to describe tradeoffs. In particular, the mathematical model developed demonstrates that the classic model, as generally specified, is by definition a stochastic/variable parameter relationship. This analysis produces significant insight into the nature of patterns in budgetary decisions, and, it is believed solidly grounds the question of spending tradeoffs in the overall patterns of shifting budgetary priorities. The existence of budgetary tradeoffs with defense is categorically identified and empirically confirmed across many sectors of the budget. And, as it turns out, a dollar more for defense does indeed mean a dollar less for social or other programs, unless you go and borrow a dollar.

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Introduction

One of the lasting puzzles of political science has been the elusive search for the existence of tradeoffs between defense and social programs. The 'Guns vs. Butter' debate has received substantial coverage in the popular press as well as the academic literature and is firmly entrenched as an important aspect of political decision making. There does seem to be a certain face validity to the notion that if the President requests or the Congress authorizes more for defense than it will have less to spend on social programs, etc.

Yet the existence of tradeoffs seems to be poorly or at best only partially supported in the empirical literature. For instance Peroff and Podolak-Warren (1979) and Russett (1982) find that defense appropriations and spending on health and education are unrelated. In a similar manner, Domke, Eichenberg and Kelleher find that "defense and welfare expenditures appear ... to be driven by separate sets of determinants which do not require one to be systematically sacrificed to the other" (1983, 33). Mintz (1989) confirms Russett's findings for the pre-Reagan era, but does find limited tradeoffs when one disaggregates the data and looks at more specific programs. The literature is replete with failed or only partially successful attempts to establish this thesis.[1] Mintz and Huang summarize this voluminous literature succinctly with "the existent literature strongly points to the absence of tradeoff relationships

[1]The literature on guns vs. butter is substantial, and will not be reviewed here. It is interesting to note the tradeoff literature sits on a cusp within the discipline since it ties into both foreign policy/defense spending studies as well as the domestic budgetary literature. The reader is referred to Russett (1970, 1982), Caputo (1975), Domke, Eichenberg and Kelleher (1983), and Mintz (1989, 1991), for brief synopses of the classic 'guns vs. butter' formulation from the defense spending perspective. Similarly Kamlet and Mowery (1987), Berry and Lowery (1990), Wildavsky (1988), and Jones, Baumgartner and True (1998) are representative of the budgetary politics tradition.

between spending on defense and spending on other programs." (1991, 738). Indeed, the topic has diminished in prevalence in recent years due to this consistent failure to find confirmation.

One is compelled to ask why the conventional wisdom so frequently fails to be empirically validated. The quest for explanation has led researchers to seek more complex models of the phenomena and more diverse types of tradeoffs. How does one measure tradeoffs? Which expenditure categories might be traded for military budget enhancement? Do we need to know how tradeoffs are determined in order to observe them? As yet the only consensus that has emerged is that tradeoffs seem to be absent in this area of the budget.

A number of basic strategies have been employed to explicate this puzzle. In particular, there appear to be three major thrusts to improving the efficacy of the models used: (1) improved or alternative measurement of the data (Gist 1982); (2) refinement or expansion of the theoretical specification of the model's components together with an altered mathematical/statistical representation (Domke, Eichenberg and Kelleher 1983; Mintz and Huang 1991); and (3) a search for tradeoffs with different or disaggregated sectors of the budget (Russett 1982; Mintz 1989; Mok and Duval 1992) and even controllable and uncontrollable expenditures (Kamlet and Mowery 1987). Often the distinction between these approaches is somewhat blurred.

Yet throughout the empirical literature, there has emerged a fairly consistent basic model used to search for tradeoffs which is simply a statistically articulated version of the conventional wisdom. The standard regression model used to search for the existence of tradeoffs is generally specified as:

$$\frac{Def_t - Def_{t-1}}{Def_{t-1}} = B_0 + B_1\left(\frac{Tot_t - Tot_{t-1}}{Tot_{t-1}}\right) + B_2\left(\frac{Soc_t - Soc_{t-1}}{Soc_{t-1}}\right) \qquad (1)$$

where ***Def*** represents Defense Outlays, ***Tot*** represents Total Budget Outlays, and ***Soc*** is spending for Social Programs of one form or another.

This model expresses the idea that a percentage increase (decrease) in social welfare spending is accompanied by a proportional decrease (increase) in defense spending. Tradeoffs are said to exist if B_2 is statistically significant and has a negative sign. Strictly speaking, we do not measure tradeoffs, but rather empirically ascertain whether the tradeoffs are 'systematic' (i.e. statistically significant as opposed to random). And in the literature, support for this relationship has indeed been limited (Russett 1982; Domke, Eichenberg, and Kelleher 1983; Mok and Duval 1992). Chan (1995), in a broader attempt to speculate on the prospects for a 'Peace Dividend' in the Post Cold-War era also remarks on the paucity of empirical support for budgetary tradeoffs suggesting that declining defense expenditures in the 90s would likely not benefit other sectors of the budget given the lack of empirical evidence of such tradeoffs.

This specification has been cogently called into question by Berry (1986) and Berry and Lowery (1990). As Berry and Lowery concur, most tradeoff models are variants of Equation 1 with other exogenous variables frequently added in the attempt to improve specification. This model archetype occurs frequently enough that Berry and Lowery (1990) classify these equations as ROCOA (Regression of One Category On Another) models. Berry and Lowery posit the following central premise: ROCOA models of budgetary tradeoffs will never capture the tradeoff because they fail to consider the nature of the tradeoff process. They then proceed to give a taxonomy of tradeoffs such as fixed pool tradeoffs, with both sequential and simultaneous choice, and floating pool tradeoffs. An alternative tradeoff indicator based upon a proportion of the incremental change in the sectors is then offered and tested. Their discussion provides significant insight into the nature of budgetary decision processes, and they make their major contribution in saying that it is the nature of the process that holds the greatest importance for us.

Yet they also state that the classic approach can never adequately describe tradeoffs because the classic models do not account for the process. This article, as it will be shown, fully agrees that ROCOA models such as the classic model and its many variants will not demonstrate the existence of tradeoffs. But the claim that we need to know the process used to generate the tradeoff in order to demonstrate that such has occurred is not so robust. Thinking about it from a personal standpoint, if someone takes money from your next raise and gives it to one of your colleagues, you will know that some budget officer has made a salary tradeoff at your expense long before you know how or why or what caused it. The existence of tradeoffs is an accounting question, albeit an important one. The finding the determinants of tradeoffs and the process by which they are arrived at it is indeed a tremendously more important political question. This article merely seeks to resolve decades of failed description in order to set the groundwork for the study of such determinants for future work.

While Berry and Lowery offer some relevant criticism of the analysis of tradeoffs by focusing on the process, the inquiry can be approached from a substantially different direction. The ability to observe tradeoffs should be independent of any decision rule used to generate them. In short, a dollar more spent on defense should mean a dollar less spent on social programs (or something else!) regardless of whether the decision rule was a splitting of the remainder of the resource pool or simply flipping a coin[2]. The existence of patterns in the expenditures should exist independent of the manner in which they were decided. In other words, the 'black box' of tradeoff decision making will not obscure the fact that tradeoffs occur. A tradeoff which is essentially unobservable is at best unimportant and is quite possibly a contradiction in terms. The formal argument and brief empirical evidence to follow will go a long way to grounding this assumption as not only reasonable, but axiomatic.

Tradeoffs: the Identity

As noted, the standard approach has been to hypothesize that the tradeoff between defense and social welfare comes as the result of the finding of statistical significance of B_2 in Equation 1. It is, however, quite instructive to see if we can deduce what the tradeoff relationship is based upon some simple and non-controversial assumptions.

In order to develop a model which will describe the changes in relative budget priority such changes need to be measured across two consecutive budgets. This is the 'short term' tradeoff as discussed by Domke, et al (1983). Therefore two consecutive budgets in $year_t$ and $year_{t-1}$ are defined as:

$$Tot_t = Def_t + Soc_t + Oth_t \qquad (2)$$

$$Tot_{t-1} = Def_{t-1} + Soc_{t-1} + Oth_{t-1} \qquad (3)$$

That is, the total budget in any given year is the sum of the outlays of the budget

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[2]Two *ceteris paribus* conditions come to mind at this point. First the total budget pie may grow, and so the gain of one category may not entail a direct loss on the part of the other category, but simply a relative loss. Secondly, a dollar more spent on defense does not mean a dollar less for something else if you simply borrow so that you can spend more on both. This is, however, simply adding the deficit in as an additional category in the equation and will be incorporated in the discussion to follow. For the moment, we simply suspend any concerns that the deficit removes the need for tradeoffs.

sectors[3]; in this simplified case, defense, social welfare and all other categories[4].

Since the literature is predominantly concerned with determining whether defense spending has constrained spending in other sectors, defense spending will be the focus of this model. Rearranging terms, defense spending is then defined as a function of total spending minus the other categories.[5]

$$Def_t = Tot_t - Soc_t - Oth_t \qquad (4)$$

$$Def_{t-1} = Tot_{t-1} - Soc_{t-1} - Oth_{t-1} \qquad (5)$$

The very notion of a tradeoff expresses an interest in change. A sector's percentage of the total federal budget indicates (at least to some degree) the relative priority of that sector for that given year. Yet the idea of a tradeoff suggests that one sector is gaining or loosing at the expense of some other. Since the federal budget grows annually based on growth in the economy and inflation we are then faced with task of determining whether a particular budget category gained or lost relative to (or at the expense of) some other sector. Change from one year to the next is thus fundamental to our loose notion of a tradeoff. Therefore calculating the change in defense spending from $year_{t-1}$ to $year_t$ requires subtracting Equation 5 from Equation 4[6]:

$$Def_t - Def_{t-1} = (Tot_t - Soc_t - Oth_t) - (Tot_{t-1} - Soc_{t-1} - Oth_{t-1}) \qquad (6)$$

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[3] We could replace Total Outlays with Total Revenues + the Deficit (Borrowing) and proceed with the analysis. In order to simplify matters at this stage, the deficit will be ignored for the moment. The analysis to follow will, however, articulate tradeoffs that include the deficit as well.

[4] Conventionally, spending has been measured by budget outlays. Recent work on budget policy suggests that budget spending authority gets to the concept of budgetary decision making better than outlays (Jones, Baumgartner and True 1998) . This discussion will continue to use outlays or spending in its discussion, but the analysis can be replicated with budget authority data with little change.

[5]This formulation would seem to result from either of Berry and Lowery's sequential or simultaneous choice models.

[6]This step could readily lead to the ever-so popular incremental models of budgeting. This discussion will not wander down the incremental path, since it is of little direct importance in this paper. See Berry (1990) or Jones, True and Baumgartner (1997) for a thorough discussion of the problems with arguments formulated around the notion of incrementalism.

Rearranging terms we get:

$$Def_t - Def_{t-1} = (Tot_t - Tot_{t-1}) - (Soc_t - Soc_{t-1}) - (Oth_t - Oth_{t-1}) \qquad (7)$$

The standard tradeoff model of Equation 1 is expressed in terms of percentage change. This has a certain logic in that it would seem that if two sector's 'piece of the pie' grew equally, indicating no tradeoff, then their percentage changes would be equal. Indeed, it is this notion of parity in percentage growth that both captures the idea of the tradeoff, and dooms regression models of it to failure.

It is here that logic and mathematical structure will briefly part ways with the traditional analysis of tradeoffs. If one wishes to see whether all of the sectors grow equally, then it might be more appropriate to subtract Equation 3 from Equation 2 and divide through by Tot_{t-1}. This would produce a series of change scores relative to the total pie. This approach has been foregone in the literature due to the desire to ascertain whether a statistically significant relationship exists between two specific sectors (e.g. defense and health or defense and social welfare).

Regression analysis compels that one of the budget sectors be the dependent variable in a classic regression design. Therefore, the percentage change in defense spending in this particular instance of the tradeoff remains an appropriate dependent variable. In order to obtain the proportional (or percentage) change in defense spending, both sides are divided by defense spending at $time_{t-1}$[7].

$$\frac{Def_t - Def_{t-1}}{Def_{t-1}} = \frac{(Tot_t - Tot_{t-1})}{Def_{t-1}} - \frac{(Soc_t - Soc_{t-1})}{Def_{t-1}} - \frac{(Oth_t - Oth_{t-1})}{Def_{t-1}} \qquad (8)$$

This result produces some interesting observations which begin distinguish this line of research from prior work. First of all, note that the percentage change in defense is not, in this formulation, directly related to the percentage change in social

[7] The step of multiplying both sides by 100 to convert proportions to percentages has been omitted for simplicity.

welfare. Indeed, the derived formulation based upon the budget model shows us that the percentage change in defense spending is a function of changes in the total budget, social welfare and other spending all relative to defense spending. The base category used to calculate the percentage change scores must be standardized across all budget categories. This makes intuitive sense as well. A 3 billion dollar increase in defense is a change of about 1% for defense spending. That same $3 billion taken from or added to say, education, represents a substantially greater 6% change.

Concern for the base in budgetary politics is not new for incrementalism thrives in this concern for the annual change in spending in budgets. The use of different bases to justify budget requests has been well described elsewhere (Kamlet and Mowery 1980). Our concern here is related but not identical. Kamlet and Mowery articulated concern for differing bases as a mechanism to justify budget requests. In so doing, previous history, previous history adjusted for inflation, and mandated outlays all can influence the 'base' used for budget requests. Since we are examining budgets only in retrospect, we simply need to select a base that represents actual change, and the history of expenditures is what we seek to explain. It is interesting to note that the base of the tradeoff component does produce the confusion inherent in the search for tradeoffs.

Some additional points about Equation 8 warrant consideration. First, it explicitly incorporates all other spending without the need to expound on these sectors in detail. The literature (including this investigator) has never considered the other sectors of the budget as a necessary part of this model specification. This identifies one major component of our collective misspecification of the tradeoff relationship. Given the problems which result from the exclusion of a relevant variable, we should anticipate that previous estimates of the tradeoff relationship which fail to include spending on other sectors are both biased and inconsistent (Maddala 1992).

One further element about Equation 8 and its interpretation is important to note.

As developed, this equation is not a 'model' for estimation. Equations 2 and 3 possess no error terms. They are definitions. As a result, the manipulation of these two definitions results in a postulate which, like the original, is articulated without error. Equation 8 is in fact an identity. Were there little literature on the subject of tradeoffs, there would be little need at this point to turn to empirical examination. However, given the volume of quantitative analysis on the topic, and its dismal record of success, it is useful to demonstrate that both the formal mathematical world and the empirical world do indeed coincide.

In order to verify that the identity produced thus far has empirical veridicality, Equation 8 is estimated with regression analysis. The model estimated and presented at the top of Table 1 is:

$$\frac{Def_t - Def_{t-1}}{Def_{t-1}} = B_0 + B_1 \frac{(Tot_t - Tot_{t-1})}{Def_{t-1}} - B_2 \frac{(Soc_t - Soc_{t-1})}{Def_{t-1}} - B_3 \frac{(Oth_t - Oth_{t-1})}{Def_{t-1}} \quad (9)$$

where, if the initial premises hold, B_0 will equal 0.0, B_1 will equal 1.0, B_2 and B_3 will both equal -1.0 and the fit will be without error[8]. In order to ascertain the empirical validity of this respecification, the tradeoff model in Equation 9 is estimated using budget outlays from the *Historical Tables of the US Budget* 1947 to 1999 (OMB 2000).[9] There is some debate over the use of outlays versus budget authority; however, outlays have been almost universally selected for tradeoff and military spending studies. (Hartley and Russett 1992; Mintz and Huang 1991)

Empirical estimation does indeed establish that Equation 9 is an identity. The coefficients estimated are as predicted with an r^2 of 1.0 indicating a perfect fit. Further Equation 9 confirms that the classic model of Equation 1 is misspecified. The right

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[8] Note that regression models are by convention expressed with positive parameters and hence produce negative estimates in this case.

[9] Confirmation of the identity will occur with data from any period in the budget. This means that this analysis has the added feature of working even during the troublesome periods of WWII and the Korean war. Likewise, the identity holds whether one uses real or nominal dollars.

hand sides of both equations do not match, yet they are comprised of nearly the same components. If you start with Equations 2 and 3 then, it would seem at first blush that, ”you can't get there [Equation 1] from here."

Table 1 also presents three other tradeoff 'tests' as well as the identity. First, the tradeoff model of Equation 9 without the Other Spending category demonstrates that the bias inherent in its omission is significant, but also that the same base model does produce statistical significant evidence for a tradeoff against health care expenditures. Statistical significance for education and social programs could also have been reported, but discussion of other sectors will be deferred for the moment. Health care has been used by way of explication since it so frequently fails to reveal significant tradeoffs. Table 1 also demonstrates this by reporting the classic model. Tradeoffs are in little evidence in the traditional formulation, and even if we add the percentage change in Other Spending in an attempt to reduce misspecification, we still see no evidence of tradeoffs for health expenditures.

This does not mean that the classic model in Equation 1 has no interpretable meaning. Indeed, further efforts at building Equation 1 from Equations 2 and 3 will provide a powerful tool in unraveling “the rest of the story”. If Equation 1 expresses tradeoffs in a manner that captures the relative nature of the exchange, then bridging from the identity to the classic model may move us further in the direction desired. Borrowing a page from classic algebraic methods of proof, hypothetical values of B_1, B_2, and B_3 can be assigned as follows:

$$B_1 = \frac{Tot_{t-1}}{Def_{t-1}} \qquad (10)$$

$$B_2 = \frac{Soc_{t-1}}{Def_{t-1}} \qquad (11)$$

$$B_3 = \frac{Oth_{t-1}}{Def_{t-1}} \qquad (12)$$

These can be substituted into the classic model along with the addition of the percentage change score for Other Spending to reveal the relationship between the classic model in Equation 1 and the identity in Equation 8.[10]

$$\frac{Def_t - Def_{t-1}}{Def_{t-1}} = B_0 + \frac{Tot_{t-1}}{Def_{t-1}}\frac{(Tot_t - Tot_{t-1})}{Tot_{t-1}} - \frac{Soc_{t-1}}{Def_{t-1}}\frac{(Soc_t - Soc_{t-1})}{Soc_{t-1}} - \frac{Oth_{t-1}}{Def_{t-1}}\frac{(Oth_t - Oth_{t-1})}{Oth_{t-1}} \quad (13)$$

Canceling terms, we can see that Equation 13, which is based upon the classic model, is isomorphic to the tradeoff identity in Equation 8. The models differ in essentially only two features. (1) the remaining spending categories which are routinely omitted as 'irrelevant' have been included, and (2) *The coefficients B_1, B_2 and B_3 which we have so vainly searched for with our ROCOA models are by definition variable ratios and not constants to be estimated*. It is therefore not surprising that regular regression methods have produced poor results. Failing to account for the tradeoff identity has hopelessly misspecified them.[11]

The difference in the two formulas can be stated somewhat succinctly. The identity firmly establishes that *controlling for the growth in the budgetary pie and changes in spending in all the other sectors of the budget, then one dollar more spent on health care (education, social programs, etc.) means exactly one dollar less to spend on defense*. On the other hand, we cannot, as yet, make statements that a certain percentage increase in defense will routinely entail a proportional change in a particular social program or any other areas. We cannot yet say that the dollars pulled from or added to defense came from any particular sector. The tradeoff identity has, at this point, established merely that for certain limited purposes the budget may be seen

[10]Equations 10-12 were obtained by solving for the factor that will convert percentage changes to the same base ratios of Equation 8. For instance, solve for Z in:

$$Z\left(\frac{Soc_t - Soc_{t-1}}{Soc_{t-1}}\right) = \left(\frac{Soc_t - Soc_{t-1}}{Def_{t-1}}\right)$$

[11]Like Equation 9, Equation 13 is an identity and results in perfect prediction when estimated with Least Squares, be it OLS with multiplicative terms or a nonlinear algorithm.

as a system and that regression of the classic tradeoff model is doomed to failure. The ostensible hallmark of a budget tradeoff, the statistically significant and negative sign of the sector suspected of exhibiting the tradeoff, is in fact not a parameter to be estimated, but is *a priori* the ratio of the two categories.

The most fruitful path of inquiry is to reexamine the classic model in light of what the identity tells us about tradeoffs. Equation 13 presented the classic model with coefficients (Equations 10-12) which establish the relationship between the classic model and the identity. This tradeoff equation provides an exceptionally interesting vantage point from which to examine sector specific trades.

The classic model fails to provide us a proper fit for three reasons. First, and most obviously, the base year is inappropriate in the classic model. Secondly, the omission of Other Spending biases the results. But most importantly, in attempting to estimate B_0, B_1, and B_2, regression attempts to find the constant value that minimizes the error variance. Yet as Equation 13 clearly points out, the coefficients we have attempted to estimate by OLS (or GLS for that matter) are in reality variable ratios. They are minimally, at least at this point, stochastic variables.

Equation 13 estimated as it is with a non-linear algorithm would produce the same identity and perfect fit. But in so doing, it gives us no further information about the relative tradeoffs that we seek. On the other hand, since the parameters to be examined in Equation 14

$$\frac{Def_t - Def_{t-1}}{Def_{t-1}} = B_0 + B_1\frac{(Tot_t - Tot_{t-1})}{Tot_{t-1}} - B_2\frac{(Soc_t - Soc_{t-1})}{Soc_{t-1}} - B_3\frac{(Oth_t - Oth_{t-1})}{Oth_{t-1}} \quad (14)$$

express the tradeoff in the classic sense and are actually the ratios in Equations 10-12, they would appear to require estimation as a state-space model with stochastic or time-varying coefficients (Beck 1983; Newbold and Bos 1985). If the ratio of Total to Defense spending were constant throughout the period of study, then OLS might have revealed the pattern.[12] If, on the other hand, the tradeoffs between defense and social welfare are at least systematic, then the ratio B_2 will exhibit systematic variation across time, and perhaps correlate with exogenous factors. If the tradeoffs are random, then the ratio will be stochastic about some mean. In short, it appears that one could apply both stochastic and time-varying parameter estimation methods to Equation 14, and determine whether the tradeoffs between any two specific sectors are systematic (time-varying) or random (stochastic). This model interpreted as a stochastic parameter regression equation would appear to have articulated the appropriate design for examination of the question.[13]

Yet the very fact that Equation 14 is an identity, rather than a model to be estimated simplifies this analysis quite nicely. Proceeding with a stochastic regression analysis of Equation 14 to determine the nature of the estimated B's is unnecessary because the ratio's in Equations 10-12 may be used directly. Because we are working with identities, we do not need to estimate the B's. We know them *a priori*. They are <u>exactly</u> the variable ratios of equations 10-12. In fact, to examine a tradeoff for a specific program such as for health or social programs, the single series represented by Equation 11 is alone sufficient to answer the question. The temporal behavior of this ratio expresses the tradeoff for the period examined. As it turns out tradeoffs, even if articulated in terms of percentage changes in the sector's share of the budget, are a simple accounting function. We can express the systematic variation in the tradeoff between two sectors of the budget simply by looking at their ratio.

A last caveat must be made. This analysis resolves only questions concerning

[12]If the ratios for all sectors of the budget were constant then OLS would have revealed the identity as well, with all coefficients being the relevant weights assigned to each sector relative to the left-hand side base.

[13]In fact, Newbold and Bos (1985) lay out the nested alternatives for testing fixed coefficient vs random coefficient vs 1st order autoregressive coefficients in a fashion that seem quite applicable to testing a regression model such as Equation 14.

the observation of systematic patterns of tradeoffs. No attempt has been made to determine either the process or determinants of the tradeoffs we expect to observe. As noted this approach takes issue only with Berry and Lowery's claim that knowing the process is a necessary condition to knowing whether tradeoffs have occurred. Definitive explanation of how to ascertain tradeoffs is quite possible without ever addressing how they happened. We have shown analytically that ROCOA models do not work because the model to be used is actually an identity, requiring no estimation. Berry and Lowery can take comfort in one important fact, however. Their choice of indicator for tradeoffs turns out to be a move in the right direction. The ratio of the raw category totals expresses the tradeoff, not the ratio of the increments. And this ratio is appropriate regardless of the mechanism used to make the trades. Having provided a definitive explanation of why earlier tradeoff investigations have failed, it is time to see what these tradeoffs have actually been.

Sector Specific Tradeoffs

Since ultimately the question of who gets what and who lost what is of fundamental importance, the establishment of the tradeoff identity leads us to a direct examination of Equation 11, the coefficient for the specific category in which we are interested. As a result of the tradeoff identity, we can now describe the tradeoff ratio as being either systematic or random. In other words, if Defense is systematically traded off against income security, then the ratio of these two sectors should exhibit systematic behavior. In ascertaining the systematic nature of this ratio, our choices are essentially four. Budget sectors which exhibit no tradeoff of any sort will result in a ratio which is constant. The two sectors always comprise the same proportion of the total budget. They grow at identical rates in a growing budget. This is patently an unlikely occurrence.

Secondly, tradeoffs may be stochastic. The tradeoff ratio will fluctuate about some mean in a completely random manner. A stochastic tradeoff means that a dollar more for defense does mean a dollar less for social welfare or some other program, but that there is no pattern of tradeoffs with any specific sector across time. Next year social welfare may just get that dollar back at the Pentagon's expense in a stochastic budgetary universe. The two sectors will basically comprise the same approximate share of the overall budget with only random fluctuations over time.

There may, however, be systematic variation in the ratio, indicating a systematic tradeoff. Systematic tradeoffs will exhibit the properties of either trend or drift, as well as possibly other temporal regularity identified by autocorrelation. Autocorrelation in such processes is often interpreted as memory. Trends indicate that an obvious long-term trade-off where one category has gained at the other's expense has occurred. Drift, on the other hand indicates that while extended periods where one category benefited relative to the other have occurred, the system does eventually return to some equilibrium level. This concern for systematic variation leads to the remainder of the analysis - the time series analysis of the budget category ratios.

Given the nature of the question, the most straightforward analysis is to simply examine the tradeoff ratio with Box-Jenkins models. The choice of Box-Jenkins is a function of the desire to discriminate the nature of the systematic variation, be it a constant tradeoff, a stochastic trade, or a systematic tradeoff such as trend, drift or some residual memory manifested by autoregressive or moving average processes.

While unit root tests are in vogue, they are not strictly desirable here. First, we are not testing models with exogenous variables, so at this stage we do not need to be as concerned as we would if we were building cointegration models for assessing causation. While it is possible that Box-Jenkins techniques might fail to discriminate between a high-order systematic tradeoff and a tradeoff with only drift, it remains very powerful in discriminating stochastic versus systematic tradeoffs. Its major virtue here is that it lets us test for all types of tradeoffs within a single methodology with a high degree of reliability. The complete lack of a tradeoff would result in a constant with no error variation. This would mean that the budget ratios were fixed to specific proportions across the entire time frame. At the other extreme, a temporal trend will indicate strong shifts in budgetary trades. In addition to trends, ratios which exhibit a large degree of drift also show systematic tradeoffs since the ratios drift from lower to higher levels due to factors we are unable to account for at this level of investigation.[14] In addition to these larger processes, significant Box-Jenkins noise models indicate that short term shifts in expenditures indicate that the trade between sectors which occurs at one time point has some residual impact upon the following years' budgets.

Table 2 provides the sector-by-sector analysis of the tradeoff ratios. Only tradeoffs between defense and the other sectors are provided here, but one could easily examine all sector-to-sector comparisons. Of the sectors analyzed, several sectors of the budget exhibit the strongest form of tradeoff, the secular trend. Spending on Health Care, Medicare, Income Security, and Justice all exhibit continuous gains relative to defense. In addition, the off-budget category Social Security also exhibits this same secular trend. While this off-budget item has not been included in the budget modeling described earlier, it provides the same end result if we also include them in to the total budget package. Again, the definition of the budget, and the tradeoffs inherent in the budget, is an accounting function. The tradeoff for social security is still the ratio. The fact that Social Security revenues and outlays are removed from the budget process by statute only means that the tradeoff has been formally institutionalized. These trends are quite evident in Figure 1. This graph provides further intuitive confirmation of the existence of tradeoffs. All five of these budget category ratios exhibit clearly increasing trends. And since these represent basic entitlement programs, it matches the intuitively appealing expectation that the entitlement programs are a major factor in driving the overall growth in the budget. The

[14] It is easy to conjecture reasons. Changes in presidential administrations or control of Congress come readily to mind (see Jones, Baumgartner, and True 1998). It is simply that speculation on the causes of these trades is outside the scope of this analysis.

elusive social programs readily demonstrate strong systematic variation against defense. There has clearly been a significant tradeoff, and it would appear that defense is the well to which other programs have gone.

Seven more functional areas, however, indicate drift. This means that tradeoffs drift in favor of one sector, but eventually move back towards the other category. Referring to Figure 2, we can see that certain categories such as the Education and Natural Resources ratios exhibit what appear to be strong trends over the 1954-1981 years only to find themselves falling back towards their original mean in the latter part of the series, the Reagan years. Yet as the data series picks back up in the post-Reagan era, the trend appears to be re-emerging. Other studies have reported the potential for the tradeoff to be stronger in the Reagan administration (Russett 1982), and this analysis would indicate that trends clearly visible prior to 1981 have reversed to some degree since that time. The finding of models which have substantial drift is strong evidence of systematic behavior, and hence tradeoffs. Many of the categories that are routinely of concern exhibit this drift. Spending on Education, Energy, Natural Resources, Transportation, Veterans, Science, and Interest on the Debt all have ratios to Defense which drift away from their mean only to drift back at some later time. These categories exhibit strong tradeoffs as well since in addition each of them also possesses strong noise models, with 1st order autoregressive processes as well. The finding of a noise model also supports the idea of a tradeoff, indicating that changes at one time point have a residual effect across following years of the budget.

Lastly, seven sectors exhibit varying degrees of systematic behavior in their noise models, but without the stronger trend or drift components in their tradeoff patterns. Commerce, Community Development, International Affairs, Agriculture, and General Government spending all have a fairly constant ratio across the period of study, but do possess a temporal pattern in the form of an autoregressive model. Interpretation of systematic tradeoffs in this context is not difficult. Random shocks to the system, say in terms of new program development, boost that category of the budget, but the existing demands of the established programs dampen the impact of such shocks over time so that the ratio returns to equilibrium after a few years. In other words Agriculture may gain relative to Defense for a year or two, but soon return back to its equilibrium level.

As noted much earlier, one way to avoid budget sector tradeoffs is to simply borrow money. Thus the deficit becomes an integral part of the budget system. When pressures upon the individual sectors are too great to reduce expenditures any more, then revenues and the deficit become the alternative means of avoiding sector tradeoffs. Appendix A provides the straightforward algebraic expansion of the tradeoff identity to include the deficit. It comes as no surprise that the tradeoff against the deficit may be ascertained by looking at the ratio of the individual sectors to the deficit.

Table 3 provides the estimates of the tradeoffs against the deficit. Here we find a quite different story. Instead of a rich mix of trends, drift and systematic variation, tradeoffs against the deficit appears largely stochastic in nature. Only spending for science seems weakly related to borrowing. The budget deficit appears to have been a mechanism to avoid tradeoffs across the board. No sector has relied upon the deficit alone to sustain itself over the same time frame.[15]

All of these findings are intuitively appealing and consistent with our conventional wisdom. The finding that all sectors of the budget exhibit systematic tradeoffs should not come as a surprise. Since we know that the tradeoff identity means that all sectors are indeed traded off against all others, this finding simply confirms that we do this in a systematic manner and that this systematic process manifests itself in varying degrees. This is highly suggestive of future research in the

[15] In all likelihood, the lack of systematic variation is a function of the extensive period of the analysis. Shorter periods, say during the period of greatest growth of the deficit, would likely exhibit stronger systematic variation. It appears that the overall period has sufficient countervailing processes to obscure any larger claims for long-term tradeoffs *vis a vis* borrowing.

area.

Conclusions and Implications for Further Research

The implications of the tradeoff identity are far-reaching. We now know categorically the basic interrelationship between changes in sectors of the federal budget across time which we have called budget tradeoffs. We also know from the budgetary literature that many sectors of the budget are driven by factors exogenous to the other programs in the budget. We find strong systematic tradeoffs between defense and health and income security, but rather weak ones for agriculture and veterans affairs. The identity expresses an interrelationship, but it does not address the fundamentally more important question of causation. In order words, education spending is not necessarily inherently driven by defense spending, but it is constrained by it. It may well be that the budget is a fixed pool sequential choice process, and that defense spending does indeed constrain education, but the fact that they are systemically traded against each other has now been deductively and empirically demonstrated.

Ultimately both are constrained by the overall budget system of which education, defense, etc. are a part. Budgetary needs (demands) for education, defense, etc. are no doubt determined by a variety of external factors. Inclusion of these exogenous influences can be incorporated into attempts to model the determinants of the budget categories themselves. We need not spend time searching for the determinants of the tradeoffs we observe. We need only look for the determinants of the spending categories themselves. Further specification will ultimately require those of us who continue studies of defense spending or any other sector of the budget to look at the budget as a full multi-equation system.

Identities provide a powerful tool for further model specification, and the models of the budget have seen their use before (Fischer and Kamlet 1984; Kamlet and Mowery 1987; Auten, Bozeman and Cline 1984). These specifications of the budget system employ the accounting identity of Equation 2 in the sense that the total spending implied by the system matches that implied by the sum of the components of the system. Fischer and Kamlet (1984) produced an early such structural system in the literature. Interestingly enough they also include a tradeoff term in their model without realizing that Crecine's Great Identity, which they also include to constrain estimation, provides all of the constraint necessary to compensate for tradeoffs. Their models thus appear over-constrained where they have also tried to incorporate tradeoffs as exogenous factors.

The research presented here has implications for much of the discipline of political science. First, a long-standing empirical puzzle has been explained and resolved. Indeed the question of tradeoffs is ultimately resolved by ascertaining whether the ratio of the two sectors is stochastic or varies systematically. And indeed systematic variation in varying degrees is the norm, not the exception. This opens the door for much more important studies of the determinants of these tradeoffs.

Lastly, the nature of the model lends itself to broadening the base of budgetary inquiry in general. First, through enhanced estimation due to the incorporation of the accounting identity as constraint, and then secondly through suggesting that we must begin to see the federal budget as a system - and a thoroughly interrelated one - which must be estimated with simultaneous equations.

It is apparent that budgetary tradeoffs exist, now let us begin to ascertain exactly why and how.

Appendix A

Expansion of the Tradeoff Identity to Include the Budget Deficit

A *prima fascia* objection to the existence of tradeoffs has been to say that rather than robbing from one sector to provide for another we will simply borrow more. This doesn't remove the tradeoff, it simply alters what is traded off against what. In order to add the deficit, we simply include it in the same model

Inclusion of the deficit to avoid sector to sector trades requires only a simple algebraic expansion of the model. Total spending needs to be expanded to equal to the sum of revenues, along with what we borrow, or have as a surplus, which we define as the deficit. This approach is not novel, even in looking at systems of budget outlays (Auten, Bozeman and Cline 1984). We may then make this substitution into the original formulation of a simple budget.

$$Tot_t = \mathrm{Re}\,v_t + Deficit_t$$
$$Def_t + Soc_t + Oth_t = \mathrm{Re}\,v_t + Deficit_t$$

Likewise, subtracting last years budget from this years and rearranging terms we get:

$$(Defense_t + Soc_t + Oth_t) - (Defense_{t-1} + Soc_{t-1} + Oth_{t-1}) = (\mathrm{Re}\,v_t + Deficit_t) - (\mathrm{Re}\,v_{t-1} + Deficit_{t-1})$$
$$(Defense_t - Defense_{t-1}) + (Soc_t - Soc_{t-1}) + (Oth_t - Oth_{t-1}) = (\mathrm{Re}\,v_t - \mathrm{Re}\,v_{-1t}) + (Deficit_t - Deficit_{t-1})$$

Again isolating defense spending on the left side and dividing through by Def_{t-1} to create the percentage change in defense spending, we get a very similar equation with the deficit built in.

$$\frac{(Defense_t - Defense_{t-1})}{Defense_{t-1}} = \frac{(\mathrm{Re}\,v_t - \mathrm{Re}\,v_{-1t})}{Def_{t-1}} + \frac{(Deficit_t - Deficit_{t-1})}{Def_{t-1}} - \frac{(Soc_t - Soc_{t-1})}{Def_{t-1}} - \frac{(Oth_t - Oth_{t-1})}{Def_{t-1}}$$

Substitution of the deficit plus revenues simply expands the identity. We can also expand any of the budget or revenue categories as well. Again, if we consider the explicit values of the coefficients of 1.0 for revenues and the deficit and –1.0 for other expenditure categories, it is clear that if we spend a dollar more on defense, we must either increase revenues a dollar, borrow a dollar, or decrease some other spending category a dollar. Or lastly, and much more realistically, we opt for some combination of these options.

In the case of the budget deficit, the important question isn't whether defense has been traded off against the deficit, but rather the broader question of what have we been willing to borrow for to support. Hence reformulating the overall identify in terms of the deficit is the more useful formulation.

$$\frac{(Deficit_t - Deficit_{t-1})}{Deficit_{t-1}} = \frac{(Defense_t - Defense_{t-1})}{Defense_{t-1}} + \frac{(Soc_t - Soc_{t-1})}{Def_{t-1}} + \frac{(Oth_t - Oth_{t-1})}{Def_{t-1}} - \frac{(\mathrm{Re}\,v_t - \mathrm{Re}\,v_{t-1})}{Def_{t-1}}$$

This reformulation also makes sense. If we spend a dollar more on Defense, or Social Programs or other areas of the budget, we will also have to borrow a dollar more, unless we increase revenues a dollar.

Again reformulating this into an estimable series of the specific sectors gives us the ratio of the spending category to the deficit as our empirical measure of whether deficit tradeoffs have occurred.

$$Tradeoff = \frac{Spending\ Category_{t-1}}{Deficit_{t-1}}$$

Of note, since we are using outlays rather than budget Authority, we appear to have avoided a significant problem. Budget authority data is generally selected in order to tap the intent of congressional policy. Yet the expansion of the identity has been accomplished with total outlays plus the actual deficit. The use of Budget authority would have compelled us to use an authorized debt figure, along with authorized revenues and produced a somewhat more ambiguous analysis.

Bibliography

Auten, Gerald, Barry Bozeman and Robert Cline. 1984. “A Sequential Model of Congressional Appropriations” *American Journal of Political Science* 28:503-523.

Beck, Nathaniel. 1983. "Time-Varying Parameter Regression." *American Journal of Political Science*

Berry, William D. 1986. "Testing Budgetary Theories with Budgetary Data: Assessing the Risks." *American Journal of Political Science* 30:597-627.

Berry, William D. and David Lowery. 1990. "An Alternative Approach to Understanding Budgetary Tradeoffs." *American Journal of Political Science* 34:671-705.

Caputo, David. 1975. "New Perspectives on the Public Policy Implications of Defense and Welfare Expenditures in Four Modern Democracies." *Policy Sciences* 6:423-446.

Chan, Steve. 1995. “Grasping the Peace Dividend: Some Propositions on the Conversion of words into Plowshares.” *Mershon International Studies Review* 39:53-95.

Domke, William K., Richard C. Eichenberg, and Catherine M. Kelleher. 1983. "The Illusion of Choice: Defense and Welfare in Advanced Industrial Democracies, 1948-1978." *American Political Science Review* 77: 19-35.

Eichenberg, Richard C. 1984. "The Expenditure and Revenue Effects of Defense Spending in the Federal Republic of Germany." *Policy Sciences* 16: 391-411.

Fischer, Gregory W. and Mark S. Kamlet. (1984) "Explaining Presidential Priorities: The Competing Aspiration Levels Model of Macrobudgetary Decision Making." *American Political Science Review* 78:356-371.

Gist, J. 1982. "'Stability' and 'Competition in Budgetary Theory." *American Political Science Review* 76:859-872.

Hartley, Thomas and Bruce Russett. 1992. “Public Opinion and the Common Defense: Who Governs Military Spending in the United States.” *American Political Science Review* 86:905-915.

Jones, Bryan D., James L. True, and Frank R, Baumgartner. 1997. “Does Incrementalism Stem from Political Consequences or from Institutional Gridlock?” *American Journal of Political Science* 41:1319-1339.

Jones, Bryan D., Frank R. Baumgartner, and James L. True. 1998. “Policy Punctuations: U.S. Budget Authority, 1947-1995” *The Journal of Politics* 60: 1-33.

Kamlet, Mark S. and David C. Mowery. 1980. “The Budgetary Base in Federal Resource Allocation.” *American Journal of Political Science* 24:804-821.

Kamlet, Mark S. and David C. Mowery. 1987. "Influences on Executive and Congressional Budgetary Priorities, 1955-1981.” *American Political Science Review* 24:804-821.

Kamlet, Mark S., David C. Mowery and Tsai-Tsu Su. 1988. "Upsetting National Priorities: The Reagan Administration's Budgetary Strategy." *American Political Science Review*

Maddala, G. S. 1992. *Introduction to Econometrics*. New York: Macmillan.

Mintz, Alex. 1989. "'Guns' vs. 'Butter': A Disaggregated Analysis" *American Political Science Review* 83:1285-1293.

Mintz, Alex, and Chi Huang. 1991. "Guns versus Butter: The Indirect Link." *American Journal of Political Science* 35:738-757.

Mok, Jin Whyu. and Robert D. Duval. 1992. "Trading Deficits for Defense and Domestic Programs: The Guns and Butter Hypothesis Revisited." in Alex Mintz, *The Political Economy of Military Spending in the United States*. New York: Routledge.

Newbold and Bos. 1985. *Stochastic Parameter Regression*. Beverly Hills, Ca: Sage Publications.

Office of Management and Budget. 2000. *Historical Tables of the US Budget*. Washington: U.S. Government Printing Office.

Peroff, Kathleen, and Margaret Podolak-Warren. 1979. "Does Spending on Defense Cut Spending on Health?" *British Journal of Political Science* 9:21-39.

Russett, Bruce. 1982. "Defense Expenditures and National Well Being." *American Political Science Review* 76: 767-777.

Russett, Bruce. 1970. *What Price Vigilance?* New Haven: Yale University Press.

Wildavsky, Aaron. 1988. *The New Politics of the Budgetary Process*. Glenview, IL: Scott, Foresman.

Table 1
The Tradeoff Identity and Selected Incomplete Models
1947-1999

Model	Constant B_0	?Total Spending B_1	?Health B_2	?Other B_3	Adj. r^2	Durbin-Watson
Tradeoff Identity Model						
Tradeoff Identity (Eq. 9)	0.0	1.0	-1.0	-1.0	1.00	NA
	([a])	(NA)	(NA)	(NA)		
Other Sectors Omitted	-1.133	.805	-9.146	-	.67	1.71
	(-.35)	(8.95)	(-3.07)			
Classic Tradeoff Model						
Classic Model (Equation 1)	-2.530	1.518	-.067	-	.72	1.48
	(-.84)	(9.29)	(-.48)			
Other Sectors Included	-1.381	1.384	-.094	-.535	.81	1.67
	(1.51)	(10.19)	(-.84)	(-4.49)		

[a] Numbers in parentheses are t-statistics. For the Tradeoff Identity the perfect prediction means that there is no error variance and hence no t-values with which to be concerned.

Table 2
Systematic Tradeoffs by Spending Function
1954-1999

Budget Category	Mean	St. Err of Est	ARIMA Noise Model 1954-1989: Noise Model	Q	r^2	Nature of Tradeoff
Education	.123	.017	$\frac{Education_{t-1}}{Defense_{t-1}} = \frac{a_{t-1}}{(1-B)(1-.962B)}$	7.36	.94	Drift
Health	.149	.011	$\frac{Health_{t-1}}{Defense_{t-1}} = \frac{.0134 + a_{t-1}}{(1-B)(1-.773B)}$	15.58	.99	Trend
Medicare	.287	.015	$\frac{Medicare_{t-1}}{Defense_{t-1}} = \frac{.0199 + a_{t-1}}{(1-B)(1-.744B)}$	6.26	.99	Trend
Income Security	.429	.046	$\frac{IncSec_{t-1}}{Defense_{t-1}} = \frac{.0177 + a_{t-1}}{(1-B)(1-.352B)}$	10.28	.96	Trend
Veterans	.126	.009	$\frac{Veterans_{t-1}}{Defense_{t-1}} = \frac{a_{t-1}}{(1-B)(1-.548B)}$	8.66	.91	Drift
Energy	.023	.008	$\frac{Energy_{t-1}}{Defense_{t-1}} = \frac{a_{t-1}}{(1-B)(1-.417B)}$	14.74	.89	Drift
Natural Resources	.059	.005	$\frac{NatRes_{t-1}}{Defense_{t-1}} = \frac{a_{t-1}}{(1-B)(1-.639B)}$	8.59	.95	Drift
Commerce	.036	.048	$\frac{Commerce_{t-1}}{Defense_{t-1}} = \frac{.0352 + a_{t-1}}{(1-.618B)}$	9.14	.37	Systematic
Transportation	.106	.011	$\frac{Transportation_{t-1}}{Defense_{t-1}} = \frac{a_{t-1}}{(1-B)(1-.406B)}$	11.12	.90	Drift
Community Dev	.032	.010	$\frac{CommunityDev_{t-1}}{Defense_{t-1}} = \frac{.0397 + a_{t-1}}{(1-.909B)}$	15.63	.85	Systematic
International Affairs	.065	.012	$\frac{IntAffairs_{t-1}}{Defense_{t-1}} = \frac{.0651 + a_{t-1}}{(1-.743B)}$	7.53	.56	Systematic

Science	.047	.007	$\frac{Science_{t-1}}{Defense_{t-1}} = \frac{a_{t-1}}{(1-.703B)}$	14.52	.92	Drift
Agriculture2	.064	.020	$\frac{Agriculture_{t-1}}{Defense_{t-1}} = \frac{.0642 + a_{t-1}}{(1-.508B)}$	15.47	.24	Systematic
Justice	.027	.003	$\frac{Justice_{t-1}}{Defense_{t-1}} = \frac{.0024 + a_{t-1}}{(1-B)(1-.724B)}$	12.28	.98	Trend
General Government	.050	.016	$\frac{GenGovt_{t-1}}{Defense_{t-1}} = \frac{.0555 + a_{t-1}}{(1-.883B)}$	8.38	.78	Systematic
Interest on Debt (Considered 'Offbudget')	.374	.033	$\frac{NetInterest_{t-1}}{Defense_{t-1}} = \frac{a_{t-1}}{(1-B)(1-.377B)}$	11.61	.98	Drift
Social Security (Considered 'Offbudget')	.656	.040	$\frac{SocialSecurity_{t-1}}{Defense_{t-1}} = \frac{.0315 + a_{t-1}}{(1-B)(1-.480B)}$	16.26	.99	Trend

[a]The standard errors are omitted for brevity. All coefficients provided are significant at p <.05, except for the Ljung-Box Qs which are χ^2 statistics with 10 d.f and are all non-significant.

Table 3
Tradeoffs Against the Deficit
1954-1999

Budget Category	Mean	St. Err of Est	ARIMA Noise Model 1954-1989			Nature of Tradeoff
			Noise Model	Q	r^2	
Education	-.319	.945	$\frac{Education_{t-1}}{Deficit_{t-1}} = -.319^* + a_{t-1}$	11.83	0.00[b]	Stochastic
Health	-.358	1.101	$\frac{Health_{t-1}}{Deficit_{t-1}} = -.358^* + a_{t-1}$	3.24	0.00	Stochastic
Medicare	-.639	1.682	$\frac{Medicare_{t-1}}{Deficit_{t-1}} = -.639^* + a_{t-1}$	2,18	0.00	Stochastic
Income Security	-.879	4.505	$\frac{IncSec_{t-1}}{Deficit_{t-1}} = -.879 + a_{t-1}$	6.28	0.00	Stochastic
Veterans	-.200	3.022	$\frac{Veterans_{t-1}}{Deficit_{t-1}} = -.200 + a_{t-1}$	8.33	0.00	Stochastic
Energy	-.046	.271	$\frac{Energy_{t-1}}{Deficit_{t-1}} = -.046 + a_{t-1}$	9.24	0.00	Stochastic
Natural Resources	-.130	.910	$\frac{NatRes_{t-1}}{Deficit_{t-1}} = -.130 + a_{t-1}$	8.66	0.00	Stochastic
Commerce	-.004	.867	$\frac{Commerce_{t-1}}{Deficit_{t-1}} = -.004 + a_{t-1}$	2.83	0.00	Stochastic
Transportation	-.161	2.287	$\frac{Transportation_{t-1}}{Deficit_{t-1}} = -.161 + a_{t-1}$	6.20	0.00	Stochastic
Community Dev	-.106	.256	$\frac{CommunityDev_{t-1}}{Deficit_{t-1}} = -.106^* + a_{t-1}$	10.22	0.00	Stochastic
International Affairs	-.139	1.700	$\frac{IntAffairs_{t-1}}{Deficit_{t-1}} - .139 = + a_{t-1}$	9.05	0.00	Stochastic

Science	-.232	.806	$\frac{Science_{t-1}}{Deficit_{t-1}} = \frac{-.230 + a_{t-1}}{(1-.262^{*} B)}$	7.27	.05	Systematic
Agriculture2	-.098	1.505	$\frac{Agriculture_{t-1}}{Deficit_{t-1}} = -.098 + a_{t-1}$	9.81	0.00	Stochastic
Justice	-.061	.262	$\frac{Justice_{t-1}}{Deficit_{t-1}} = -.061 + a_{t-1}$	4.97	0.00	Stochastic
General Government	-.107	.713	$\frac{GenGovt_{t-1}}{Deficit_{t-1}} = -.107 + a_{t-1}$	7.12	0.00	Stochastic
Defense	-1.580	27.007	$\frac{Defense_{t-1}}{Deficit_{t-1}} = -1.580 + a_{t-1}$	9.69	0.00	Stochastic
Interest on Debt (Considered 'Offbudget')	-.700	4.28	$\frac{NetInterest_{t-1}}{Deficit_{t-1}} = -.700 + a_{t-1}$	5.92	0.00	Stochastic
Social Security (Considered 'Offbudget')	-1.337	7.23	$\frac{SocSec_{t-1}}{Deficit_{t-1}} = -1.337 + a_{t-1}$	6.77	0.00	Stochastic [c]

[a] The standard errors are omitted for brevity. Those coefficients indicate are significant at p <.05, except for the Ljung-Box Qs which are χ^2 statistics with 10 d.f and are all non-significant.

[b] Models with only stochastic behavior represent only random variation about the mean, and thus will have r^2s of 0.00 – by definition as well as by estimation. In addition, the mean of the series will be identical to the estimate in the model equation.

[c] The On Budget portion of Social Security, not reported here, does have a systematic moving average process with respect to the deficit.