In 1999, Rafael Domenech, David Taguas, and Juan Varela submitted their paper entitled, “The effects of budget deficit on national saving in the OECD.” In June of 2000, the paper was accepted, and today I will outline my process for replicating the paper. The paper makes one main claim, that Ricardian equivalence does not hold in the OECD countries. So, the logical first step in outlining my replication is to explain clearly and simply what that means.

Ricardian equivalence, like many economic theories, is based on the concept of the rational consumer. In 1820, David Ricardo postulated that whether or not a government chooses to finance an effort by raising taxes today or by raising them tomorrow, the result is the same. An example makes this simple idea clearer. Suppose the United States believes it can stimulate the economy by committing some large sum of money to renewable energy. To finance the endeavor, the government could raise its citizens’ taxes today or it could issue bonds to be payed back over some number of years. In this example, the government chooses to issue bonds. Ricardian equivalence says that the consumer is forward looking and because of this, he or she would recognize any debt financing as a public debt and respond by saving in anticipation of increased taxes down the road. Because the consumer decides to save today, the stimulation to the economy is muted. Simply, Ricardian equivalence says that private savings responds one to one with public debt. Now that an understanding of the theory being tested has been achieved, let’s look at why the theory is being tested.

Reordering a portion of the authors’ abstract and introduction as follows should help us to understand why the Ricardian equivalence hypothesis is being tested. “The last thirty years have witnessed a significant decrease in investment and saving rates in OECD countries (see, for example, Elmeskov et al., 1992). Besides this fact, real interest rates have shown an upward trend in almost all countries, as a consequence of the underlying factors explaining the movements of investment and saving rates…Our results suggest that Ricardian Equivalence did not work in our sample of OECD countries, since private saving compensated only a small fraction budget deficit. This supports the interpretation that the large budget deficits have been a very important factor behind the significant increase in real interest rates in the eighties and early nineties” (Domenech, Taguas, Varela, 2000). Put more plainly, the authors have reason to suspect that the economic effects of large government deficits are not cancelled out by the response of the rational consumer. The why and the what are now established and so with the big picture clearly in view, we can begin to get our hands dirty and untangle the weeds.

A visual examination of some basic claims made seems like a natural starting place. There are two assumptions that the introduction makes. One, that savings rates are decreasing, and two, that real interest rates are increasing. Figures 1 and 2 depict the interest rate and savings rate among the G7 nations. (G7 nations are used in place of the full sample of 18 nations examined for visual clarity)

A close up of a map

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Fig (2)

For the sample the paper analyzes, 1962-1994, the two claims appear accurate. Although, it should be noted that from 1990 on, there is a clear and sharp downtrend in interest rates. The presence of these new data could draw some criticism to the conclusion that budget deficits are a “very important factor” in the increase in real interest rates. But, more on this later. The next data to inspect should be our working variables, namely the budget deficit and savings, both as a percent of GDP. For the sake of clarity, I will use just one country’s data.



Fig (3)

Immediately, there is a question about how the deficit could be a negative percent of GDP. To understand this, it is imperative to know that the deficit is really a singular measure of both surplus and deficit so that an observation of zero would imply that the United States government is operating with exactly no margin. To clarify, the -13% observation in 2008 signals the largest recorded deficit in the sample while the 1% observation in 2000 represents the only time that there was a surplus. The next thing to note is that the two series appear to move in tandem. As the deficit peaks and troughs, so do savings. This second observation is problematic from the perspective of a Ricardian equivalence maximalist. If the deficit is on the rise, shouldn’t we expect to see savings increase? Figure 4 shows what a simple plot of savings and the deficit should look like. That is, that savings should increase in proportion to the change observed in the deficit. Now that we’ve had a look at the variables that we will be working with, it’s time to discuss what will be done with them.

Fig (4) A screenshot of a cell phone

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Because the possibility exists that Ricardian equivalence might only be observed in the long-run, the sample size of the data is small, and that “different types of shocks could offset the reaction of private saving to budget deficit, ” (Domenech, Taguas, Varela, 2000) the authors decide to estimate the reaction of savings to the changes in the deficit using a vector autoregression identification. More specifically a long run structural vector autoregression is used with the following identification scheme.

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Before I get into the results of the paper and my own recreation of the results, it’s necessary to deconstruct what a SVAR is and explain the steps needed to solve one. A long run structural vector of autoregressions is essentially a set of equations that must be solved simultaneously because of the nature of their relationship. When two or more variables affect each other at the same time we say that the relationship is contemporaneous. The structural form of our two variable equation is shown in figure 4 where Y is savings and C is deficit.

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Fig (4)

Because we are dealing with a set of simultaneous equations, we cannot directly estimate the pair as is in figure 4. To estimate this equation, we have to first estimate the reduced form equation given in figure 5. Figure 5 shows a basic VAR where both Y and C are simply a function of lags of each of the two variables. After estimating the reduced form, the coefficients in the reduced form (b11, b21, b12, etc) can be used to calculate the coefficients in the structural form once we assume a restriction. Recall from before the identification scheme. The 0 in that matrix corresponds with the restriction a03 = 0. That is restriction we will use to solve our equations. But why? Why must a03 = 0? Why not a04 or a01, and why not impose a restriction equal to 1 or 2 on a03? You’re asking all the right questions and I love it. Be sure to look at figure 5 and stick with me.

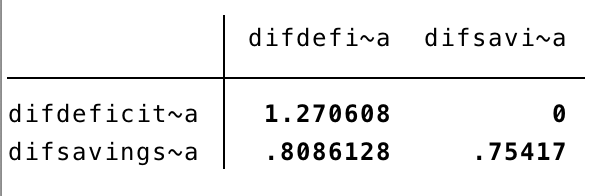
A close up of a clock

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A close up of text on a white background

Description automatically generatedFig (5)

The short answer to your very astute question is, theory. We let previous economic theory or reasoning define the restriction to be used. For the long answer, let’s look again at our identification scheme (fig 6), but this time the results from our estimation from US data will be used. 1.271 is interpreted as the long run response (in percentage point change) of the deficit (national balance) to a positive shock in the deficit. 0.809 is the national savings response (in percentage point change) to a positive shock in national savings. Similarly, 0.754 is interpreted as the long run response of savings to a positive shock in the national balance. Now notice that there is no estimate effect for a response from the deficit to a shock in savings. It is forced to be zero because of a, “lack of any theoretical model implying that changes in private saving have long-run effects on the government budget constraint” (Domenech, Taguas, Varela, 2000). In other words, a change in national savings today has no effect on the budget balance tomorrow. Theory has been our guide and has led us to the last piece of our puzzle, the identification restriction.

Fig (6)

With all the pieces now in place, let’s power walk through all the steps to estimate a SVAR. First, we need to inspect our variables and be sure that the mean of the data is consistent, or in technical terms, be sure the working data is stationary. Savings and deficit have already been depicted (fig 3). By simply eyeing them, it is unlikely that they are stationary. Our authors confirm for us that the variables are not stationary, but as a check, I will show that they are not by using a Dickey-Fuller test (Fig 7). The hypothesis of a Dickey-Fuller test is that of a unit root (non-stationarity). The high p-values resulting from the two tests tell us that there is not enough evidence to reject the presence of a unit root and so we will have to take the first difference of each variable. It is good practice to then test the differenced data for a unit root. The results of this second test confirm the likely absence of a unit root but will not be pictured.

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After applying a difference, the next step is to select the number of lags to be used in our reduced form. We must search for the appropriate amount of lags in order to try and eliminate any serial correlation within the residuals. With out giving specifics, the authors identify an optimal number of lags to be 3. In my own tests, two of the four test criteria identify 3 to be the optimal choice while the other two choose only a single lag. In these situations it is best to error on the side of too many lags than too few. So 3 lags it is.

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After identifying the optimal lag length, the reduced form VAR can be estimated, followed by the translating those results to the SVAR. However, most statistics software packages estimate the SVAR by a single command. The authors’ results of interest, being the response of savings, are tabulated by country in figure 9. At this point we reach the first major split in methodology between the authors’ approach and my own. The difference is due to the fact the authors used a panel of data and estimated the effect to the exclusion of one country at a time. Due to my limited ability in STATA, I had issue reproducing the results of a long-run panel and found the results of testing one country at a time to be largely similar in consequence. For example, the average long run effect of savings from a shock in the deficit in the paper is 0.817 while my own estimated effect from my most complete sample is 0.808 in the USA (observed in figure 6). What’s important to note about both of these figures is that neither should be interpreted as the response to a one percent change in the deficit, but as the response to a one standard deviation change in the deficit. In the authors’ panel, the deficit’s response to a one standard deviation change in the deficit averaged to be 1.33, meaning that there was a 1.33 long run percentage point change in the deficit as a response to a shock in the deficit. Again, in the USA I observed a 1.27 long run percentage point change. With these responses defined, we at last have everything that we need to test the Ricardian equivalence hypothesis. But first, let’s briefly explore the impulse response function of the SVAR.A screenshot of a cell phone

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Figure 10 is essentially a graphical representation of the numbers that we have already gone over. Pictured on the left is the average long run response of all countries savings to a negative shock in the deficit. On the right, you see the US savings response to a positive shock in the deficit. Recall that shocks are standard deviation increase or decrease so the two graphs are showing nearly identical responses but in the opposite direction. Because the sample used for just the US is much smaller than the more robust panel used by the authors, the short run movement is much more pronounced. However, the same basic pattern of a higher initial response followed by a dip and then a leveling out at roughly 0.8 around the 10-year mark. Now that we have seen a visual of the response function, Ricardian equivalence can be tested.

The Ricardian equivalence hypothesis states that the response of savings should be the same as the response of the deficit. Using my own estimates, obviously 1.27 and 0.808 are not the same response. By the authors’ words, “After three years, following the increase in public debt as a consequence of the negative shock in the budget balance, national saving falls by one point, but its long-run response is around 0.8 points, indicating that private saving compensates only a 40 per cent of the negative shock in public accounts… The exact number is given by 1-(0.817/1.33), where 1.33 is the long run increase in the public debt and 0.817 is the cumulative response of the national saving,” (Domenech, Taguas, Varela, 2000). The exact response of savings found is 38.57%. In my own results I estimate 1- (.808/1.27) or 36.38% (in the US). Figure 12 corresponds with figure 9 and shows my individual estimates in terms of percentage compensated. There is much more variance across the different samples in my results. Much of this is due to the smaller sample size since each is estimated individually. However, both the authors and I both find that, on average, private savings compensate only roughly 40% of long run negative shocks. These results are not consistent with the Ricardian equivalence theory. The authors finish up in their conclusion by stating that the results are, “Consistent with the interpretation that budget deficit and long-lasting deficits seem to be important factors explaining higher real interest rates and lower national saving, with negative effects on welfare and growth in the long run.” Most of that conclusion makes sense. But real interest rates haven’t been mentioned in the paper sense the introduction and unless there is some sort of economic theory suggesting that long run budget deficits cause higher real interest rates, then I’m not convinced of this statement. Thus, my extension will be to collect real interest rates from OECD.org and analyze the response of real interest rates to a shock in the deficit.

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Earlier, I noted that one of the assumptions of the authors was that real interest rates were increasing. This was true up until the 90’s (recall figure 2). Since the 90’s, there has been a consistent decrease in the interest rate. To test the authors conclusion, we will use the same approach as was used with the national savings. Because the authors claim that there does appear to be evidence for a real interest rate response to budget deficits, and because I am not aware of any evidence that higher real interest rates cause budget deficits, I will use the same identification scheme as used before. Going back and looking at the two series we see that the interest rate is probably not stationary, and we know that the deficit is not. So we are going to follow all the steps from before. Test for a unit root, transform by first difference, estimate the optimal number of lags, estimate the SVAR, and finally graph the IRF (all steps taken will be provided in the log). Let’s look at the long run response function in figure 13.

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Because the graph represents a positive shock to the deficit, this graph shows that the response of the interest rate to a shock that shrinks the budget deficit is an increase of 0.2 percentage points. This is exactly opposite of what we would expect to see if we thought that large budget deficits were a causal factor of higher real interest rates. We would expect to see the interest rate rise as the deficit grew larger, not as it shrinks. At the time of publishing, there was missing about 25 years of interest rate shrinkage. Because of this, the idea that the high interest rates were caused in large part by persistent budget deficits might have been an assumption with some weight behind it. However, with the data we have now, the idea might not hold up as well. At the very least it would appear that the interest rate is affected much more strongly by some other factors.

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<https://blog.stata.com/2016/10/27/long-run-restrictions-in-a-structural-vector-autoregression/>

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**LOG**

All data and code used can be found at the public link below.

https://github.com/volney4/OECD-recreation.git