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Colonial Virginia's paper money, 1755–1774: a reply to Michener

FARLEY GRUBB
University of Delaware

Ron Michener takes issue with my approach to and analysis of colonial Virginia's paper money. He objects to how I calculate the paper money's asset present value when the paper money is hypothesized to be zero-coupon and interest-bearing bonds. He questions my data on the amount of Virginia's paper money in circulation, and he objects to the econometric treatment I apply to my model of that money's performance. He, however, presents no alternative data constructions, or any alternative explanations for the patterns in the data, nor does he present any alternative hypotheses or do any hypothesis testing to account for the level and movement in the value of Virginia's paper money.

I

Michener claims I incorrectly constructed the paper money's asset present value (APV). He says I constructed it as an average utility measure. He says I should have constructed it as a marginal utility measure. This is because a utility-held-constant demand curve represents the marginal, and not the average, utility at each point. He also claims I constructed APV as 'an inverse function of the current money supply' thus making the current paper money supply (M) and APV mechanically related. This in turn invalidates any estimated relationship between M and any variable with APV in it. He is disputing my APV analysis because he does not want anyone to think about colonial paper monies in asset terms. Michener wants everyone to think of colonial paper monies as fiat currencies.

Both of Michener's claims are fallacious. With regard to the first, he makes a fundamental error in microeconomic theory. With regard to the second, he fails to do minimal due diligence in investigating how I construct APV.

Michener's wormy apples

Nowhere do I say I constructed APV as an average utility measure. Michener made that up. I constructed APV as the expected payoff from a random draw from a known distribution of payoffs. An analog is the expected payoff to buying a lottery ticket. Suppose there are 100 lottery tickets for a $100 prize with only one ticket winning

The author is professor and NBER research associate, Economics Department, University of Delaware, Newark, DE 19716, USA; email: grubbf@udel.edu. Web page: http://lerner.udel.edu/faculty-staff-directory/farley-grubb/

it all. What is the expected payoff of one randomly drawn ticket? Another analog is to ask what value you would place on say the fortieth apple purchased, namely where your demand curve for apples is located at the fortieth apple, if the fortieth apple is randomly drawn from a bin of apples with a known distribution spanning from excellently crisp to wormy?

If we translate these examples into utility-held-constant demand curves – what Michener implicitly does – then your demand curve is the *average* of the marginal utilities of the quality of goods available to be randomly drawn from, or across the set of lottery tickets available to be randomly drawn from. Michener mistakenly claims that your utility-held-constant demand curve is the *marginal* of the marginal utilities of the quality of goods or tickets to be randomly drawn from. The expected value of one lottery ticket in the above example is $1. This value is the *average* of the marginal utilities of the set of tickets available to be drawn from. Michener would claim that the value is the *marginal* of the marginal utilities of the set of tickets available. Now 99 tickets will pay zero, so the *marginal* marginal utility of a ticket is zero. For Michener, therefore, all lottery tickets have zero value and should sell for a zero price. Similarly, Michener would claim that your utility-held-constant demand curve for the fortieth apple randomly drawn from a bin of excellent to wormy apples is the marginal utility of the wormy apple as that is the *marginal* marginal utility of the apple in the bin of apples to be randomly drawn from.

Virginia's treasury notes (paper money) have the same heterogeneous quality dimension as the analog examples above. Only some of the notes outstanding will be redeemed each year – never all of them. While the amount redeemed each year is known, which notes will be redeemed is unknown – and so I modeled the process as a random draw from a known distribution of payoffs. In essence, you are calculating the *average* of the marginal utilities of the set of notes available at that point. The *marginal* marginal utility in that set would be the value of a note redeemed at the very end of the established redemption window – the last note redeemed at a fixed future date. Grubb (2016, pp. 168–71) explains this thoroughly – a work Michener cites and supposedly read.

In conclusion, Michener commits a fundamental error in microeconomic theory. He conflates average utility with the *average* of the marginal utilities, and conflates marginal utility with the *marginal* of the marginal utilities. This should give the reader cause for concern.

Michener's lack of due diligence

My construction of APV is not 'an inverse function of the current money supply' nor is APV mechanically related to the money supply as Michener asserts. Michener leaps to this conclusion by looking at equation (4) and seeing M in the denominator of that equation (Grubb 2018a, p. 129). Michener, however, does not evaluate the complete formula used to calculate APV.

For any given M, APV can take on any value from zero to 100 percent of face value depending on how the legislature sets and executes the length of the redemption

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window (N) and where, within that window, yearly redemption amounts (RED) are lumped. For the same M, APV could be very high if N is short and RED is lumped at the beginning of that window or very low if N is long and RED is lumped at the end of the window period. All M is doing in the calculation is weighting the individual yearly RED contributions across the window of years. It turns yearly raw RED amounts into their percentage contributions to the time-discounting calculation. The absolute raw values of the REDs in the APV calculation, when APV is measured as a percentage of face value, are meaningless.

Therefore, to assert that APV and M are mechanically related, you need to show that M and N are mechanically related, and that M and RED are mechanically related. Michener does not do this. Even a cursory look at Tables 1 and 2 in Grubb (2018a) shows that N and RED are not mechanically related to M. Therefore Michener's objection to my panel D regression in Table 3 in Grubb (2018a) is erroneous. That regression stands as correctly done and correctly interpreted. In conclusion, Michener does not exercise the minimum due diligence required to support his claim, a claim which is shown here to be wrong.

II

Michener questions my data construction of M. He does this by presenting two committee reports he found in the secondary literature, one for 1767 and one for 1768. These reports list different numbers for M in these respective years than what I report in my data reconstruction of Virginia's paper money accounts (Grubb 2017, p. 106). Michener's two committee reports, however, are from early April of their respective years, before most redemptions of paper money for that year took place. My data for M in a given year include removing all redemptions that took place in that year. Therefore, the most relevant comparison of the committee reports is to my data from the prior year and not to my data from the committee reports' current years. As such, the difference between the committee reports and my data is small (as even Michener admits) being only 7 percent more for 1767 and 1.7 percent more for 1768 in the committee reports than in my data, respectively, and not the 23 percent and 20 percent more, respectively, that Michener parades in his article.

Michener blindly accepts these two committee reports, as presented in the century-old secondary literature, as truth without doing any investigation. It is difficult to figure out how the committees arrived at their numbers. In particular, it is unclear how the committees counted notes redeemed but not yet burned, and how the committees dealt with notes printed but never actually emitted to the public – their treatment of such appears to erroneously inflate their totals. I made adjustments for both these issues. These adjustments explain my slightly smaller M than what the committee reports related. This is all well explained in Grubb (2017, pp. 103–14). Michener ignores all these issues. Again, Michener's lack of due diligence and forthrightness should give the reader cause for concern.

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Michener claims that because specie that was earmarked for redeeming notes was sitting unclaimed in the treasury in the late 1760s and early 1770s the notes cannot be characterized as zero-coupon bonds. I, however, explicitly estimate the amount of specie sitting in the treasury for this purpose. I show that there were always more notes outstanding than specie in the treasury to redeem them, and I explicitly discuss the 100 percent reserve backing and redeemable-upon-demand nature for the portion of notes that had reached their end maturity dates but remained in circulation. I also incorporated such into my APV calculations (Grubb 2018a, pp. 125–6, 128).

For the average or representative note in circulation, some are valued at 100 percent of face value in that they were redeemable-upon-demand at face value in specie at that point while other notes were not. These other notes still need to be time-discounted from their expected future redemption dates. When taking the expectation from a random draw of such notes you still get an average value trading below face value due to time discounting. Michener apparently did not read my article. Again, Michener's lack of due diligence and forthrightness should give the reader cause for concern.

III

Michener claims that the econometrics I report in Table 3 (Grubb 2018a) are wrong, and when he redoes them his way he gets nonsense – wanting the reader to conclude that my whole approach is nonsense. He claims that the econometrics are the 'heart' of my study and so my whole approach rises and falls with their success and failure. He also claims that his alternative specifications – specifications that yield no statistically significant results on the relevant variables – are preferable. In place of econometric analysis, Michener provides no alternative explanation for the value and performance of Virginia's paper money.

If I'm not mistaken, Michener has never published applied econometric estimates in any of his prior work on colonial paper money, work that spans over 30 years of research on the topic. His comment here appears to be his first to do so. In his comment here, as well as in past articles, Michener has expressed a distain for applied econometrics, holding that it is a methodology that has no value and should not be used. As such, his goal here is to demonstrate that belief.

Michener's tell-tale heart

Nowhere do I say the econometric applications in Table 3 of Grubb (2018a) are the 'heart' of my article – as Michener claims it is. Michener made that up. The heart of my article lies in equation (2) and Figure 1 – which Michener leaves unchallenged. As such, Michener is trying to distract the reader away from the true heart of my article and into his own econometric hash. Nothing Michener does to my econometric analysis changes the results derived from equation (2) and displayed in Figure 1 (Grubb

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2018a, pp. 127, 130). The econometric results could be entirely eliminated and the results displayed in Figure 1 would still stand.

The data for colonial Virginia's paper money regime span only 20 years, and the key variables, namely the market exchange value (MEV) and APV, are measured with error. Applying time series econometrics to such a short data span using variables measured with error can only be illustrative at best. Trustworthy standard errors are difficult to generate under these circumstances. A person would be foolish to make such an econometric exercise under these conditions the 'heart' of their article, or go to the mat over particular econometric results, or dwell exclusively on statistical significance. The same can be said for anyone who would make such an econometric exercise the core of their comment. The econometric exercise in Table 3 is only illustrative of and ancillary to the core results displayed in Figure 1 (Grubb 2018a, p. 130).

In Figure 1, MEV and APV are generated by independent processes. Either can take on any value between 0 and 100 percent of face value. To suggest, as Michener clearly intends by making an econometric hash of things, that MEV and APV in Figure 1 are unrelated in terms of levels and movements is to stretch credulity. APV is a compositional component of MEV, part of an identity. That APV as a component of MEV dominates MEV in terms of component composition cannot be denied from the data in Figure 1.

Michener reports two replications of my results, panel A and the first regression in panel C, from Table 3 in Grubb (2018a) and Table 1 in his comment. Michener's replication of my panel A results is slightly different, but not different enough to affect anything or be statistically different from what I report. The source of the difference in our results for panel A is an error I made in copying the results from Grubb (2016, p. 182), where I had previously done that estimate, into panel A of Table 3 in Grubb (2018a). First, I forgot that in the 2016 article I used a 21-year data span, 1755 through 1775, rather than a 20-year data span, 1755 through 1774; the latter I subsequently came to regard as more appropriate historically, so I used it in the rest of the work done in the 2018 article (Grubb 2018a). Thus, the '*N*' I report for panel A is incorrect and should be 20.

Second, in Grubb (2016, p. 182) I ran two specifications, one with a time-span dummy variable and one with the same time-span dummy variable interacted with time (year). I copied the coefficients from the specification using the time-span dummy variable interacted with time rather than the coefficients from the specification with just the time-span dummy variable. The difference in the coefficients between the two specifications is close to nil. Any researcher exercising a modicum of due diligence would have run both specifications as reported in Grubb (2016, p. 182) and seen the transcription error, and seen that that error did not matter. Michener did not do this. Michener's panel A results are the same as what I produced for Grubb (2016, p. 182) in the unreported specification of the two specifications run.

The other regression of mine that Michener attempts to replicate is the first regression in panel C. Why Michener's results differ from mine is unclear. His standard errors are about the same, and his coefficient on APV is about the same, but his

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constant term differs substantially. His results, however, simply prove my point because the OLS coefficient on APV in this regression is an unbiased estimator (Michener points out that the standard errors are biased, but that should not detract from the fact that the coefficient itself is unbiased). That coefficient indicates that MEV and APV are tightly related with a coefficient near 1. In Michener's co-integration test run off this regression something is wrong as he reports a sample size of 20 for that test, which is inconsistent with his other regressions.

Finally, the co-integration tests are largely irrelevant because the model estimated is an identity; see equation (2) in Grubb (2018a, p. 127). The whole point of worrying about random walks and non-co-integration in a time series is that there may be some other unidentified force driving both variables and so the two variables in question are not really related, or the systematic relation estimated in the regression between these two variables is spurious. That worry falls away when the estimation exercise is about tracking the components of an identity. There are no other forces outside the identity. A decomposition estimation exercise for an identity is different from a causal regression exercise using truly independent variables open to outside-force influences. Michener fails to grasp the identity nature of the underlying model and so applies the wrong econometric assessment standards.

Michener puts the 'con' back into econometrics

Michener's effort at correcting regressions in, and supplying 'missing' regressions to, my Table 3 (Grubb 2018a) as he reports in his Table 1 is an exercise in applying the standard econometric tricks needed to produce insignificant coefficients. Michener is hung up on statistical significance as the only thing that matters, which, given the short span of data and measurement error in the variables, is a straw man. First, for a univariate time series, that series can be replicated (a tight fit can be achieved) by using some set of time dummy variables and/or time polynomials. Doing so does not mean anything as you have just replicated the data in a different form. But doing so reduces the influence, especially in statistical significance terms, of the other non-time variables. You can see Michener doing just this in his corrected regressions in panels A and B where he adds overlapping time dummy variables, one of which remains statistically insignificant and so whose sole purpose is to dilute all results in terms of statistical significance. His corrected regression in panel A has an R^2 of 0.74 but virtually no statistically significant coefficients out of five terms on the right-hand side.

Michener does the same trick in the 'missing' regression in panel C, namely adding in time variables, continuous and dummy, thus driving the other non-time variable to insignificance. His 'missing' regression in panel C is also miss-specified because it is estimating the composition of an identity, an identity that does not have an independent time factor.

Finally, Michener's altered specification for panel D is nonsense. As argued above, Michener's objection to my specification in panel D (Grubb 2018a, p. 136) is erroneous and so my specification and its results stand. His alterative specification in his

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panel D, however, is both nonsensical and old news. First, why a lagged gap between MEV and APV is included on the right-hand side is a mystery. Michener does not explain this aberration in his specification nor does it make sense based on my model in equation (2) in Grubb (2018a, p. 127).

Second, the lack of a statistical relationship between MEV and M is old news. MEV can be used as an inverse proxy for prices in a quantity-theory-of-money estimation. I have estimated that effect elsewhere and found little relationship between MEV and M. It is similar to the common finding in the literature of little relationship between price indices and M in most colonies south of New England (Cutsail and Grubb 2017; Grubb 2019). Lastly, Michener calling his panel D regression a 'Transaction premium regression' is erroneous. He has no transaction premium measure on the left-hand side of his regression.

IV

Michener's comment here is his fifth published comment on my research (the other four being: Michener 2018; Michener and Wright 2005, 2006a, 2006b). My rejoinders to these other four comments are in Grubb (2005, 2006a, 2006b, 2018b). If I am not mistaken, Michener's five published comments represent a majority of his published articles in scholarly journals over the last 20 years. And if I'm not mistaken, there has not been an original research paper on colonial or Revolutionary era paper money that I have published in a scholarly journal over the last 20 years that Michener has not written and submitted a comment on – submissions that have been mostly rejected by editors. Michener and I were PhD students in economics at approximately the same time at the University of Chicago. While readers might think that Michener's 20-year obsession with me is unseemly and weirdly personal, I could not possibly comment.

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