Fiscal Multicointegration and Sustainability in OECD Economies

Rajlakshmi De

Professor Lori Leachman, Faculty Advisor
Professor Kent Kimbrough, Faculty Advisor

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Abstract

Policies surrounding government expenditures and revenues are often concerned with the size of the national public debt and whether it is sustainable or not. In this paper, the recent fiscal trends of 14 OECD nations are assessed as sustainable or unsustainable by employing the multicointegration framework and asserting corresponding criteria for sustainability. Denmark, Norway, Finland, Canada, Sweden, Portugal, and Austria are found to exhibit sustainable fiscal policies during the paper's sample period, whereas the policies of the United States, Italy, France, Netherlands, United Kingdom, Spain, and Japan are determined to be unsustainable.

JEL classification: E6; E61; E62; E66

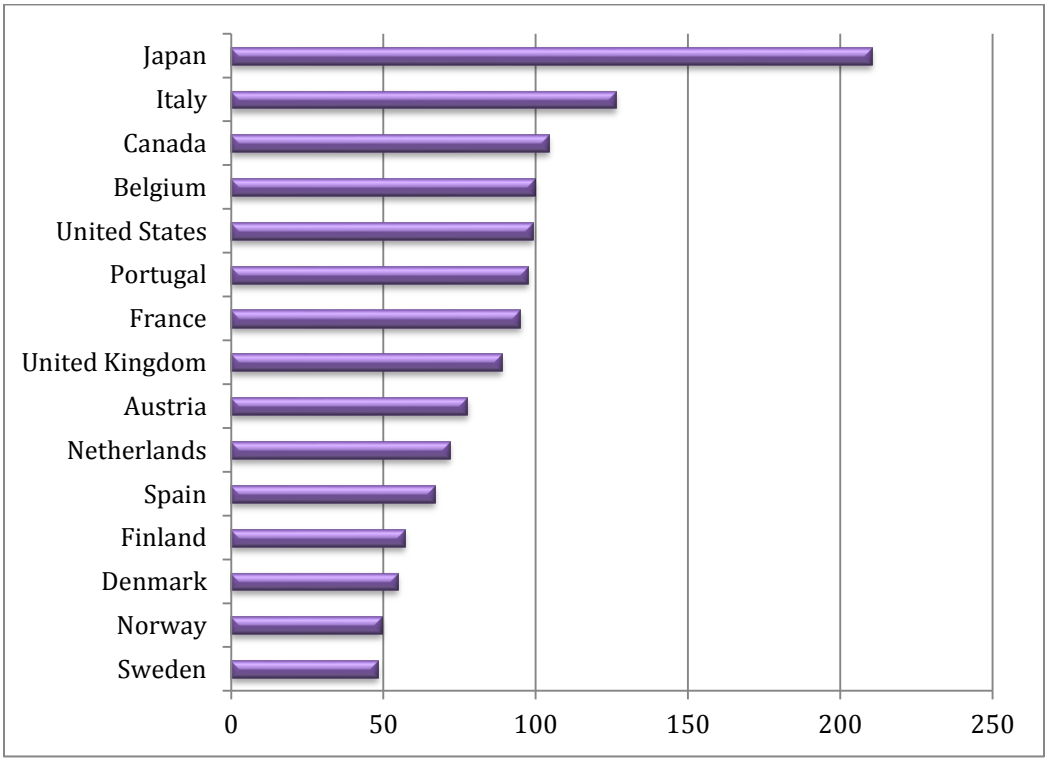
Keywords: Fiscal; Sustainability; Multicointegration

I. Introduction

Policymakers and economists have often voiced concerns about rising public debt levels and whether national fiscal policies are sustainable or not as a result, especially in recent years when debt/GDP figures have reached near 100 percent or higher in nations such as Japan, Italy, Canada, the United States, and Portugal. In the United States, for example, politicians hardly ever agree on the appropriateness of the size of the public debt and whether it has implications for either raising revenue or reducing expenditures. In Spain, recent news reports note that its debt/GDP is the highest recorded since 1910, causing concern about whether the fiscal trends are unsustainable and need reform. Debt/GDP percentages are also sometimes influential for policymaking targets, such as the required (though not enforced) 60 percent limit on debt/GDP for Eurozone countries. Debt/GDP percentages in 2010 for 15 OECD nations are shown in Figure 1.

FIGURE 1

PERCENT PUBLIC DEBT TO GDP IN 15 OECD COUNTRIES, 2010



Source: OECD Factbook

However, Debt/GDP figures alone are not insightful in determining whether fiscal policy trends are sustainable or not. This is because a country with higher GDP growth can finance larger deficits much more readily than a country with a lower GDP growth rate. This importance of economic growth to debt repayment was illustrated recently when Moody's, a credit rating agency, removed the United Kingdom's AAA credit rating, citing that the medium-term growth outlook is "sluggish" (Pratley). Therefore, in order to substantiate or contradict fears about debt/GDP percentages in various OECD nations, analyses must account for fiscal policy decisions occurring in a dynamic setting where GDP growth is variable and affect the stochastic discount factor of debt. To achieve this, a multicointegration framework is employed to analyze the fiscal policies of 14 OECD nations, where multicointegration is the existence of dynamic equilibria relationships of both a first cointegrating relation between revenue flow and spending flow and a second cointegrating relation between the stock of debt and the flow of revenue. These two relationships are measured for each nation in order to check first for the accumulation of deficits (or surpluses) and secondly for a corrective policy response to the accumulated debt (or savings). Revenue and expenditure data are percentages of GDP. This framework is employed because, as noted by Bohn (1995,1998) and Leachman et al. (2005), the presence of multicointegration (with corrective policy responses) using this specification indicates sustainability regardless of whether GDP growth is higher or lower than the interest rate on sovereign debt as well as ruling out a government's need to use default or inflation to absolve debt.

Criteria for sustainability are drawn from past literature that requires both multicointegration and corrective policy responses to be classified as sustainable. However, it is asserted that countries accumulating surpluses are not required to fulfill the multicointegration and corrective policy response criteria for this study. In particular, Norway, Finland and Denmark do not exhibit both multicointegration and corrective policy responses in this study's sample time period, but they exhibit

persistent surpluses and thus are classified as having sustainable fiscal trends. Norway provides an interesting case study of a negative relationship between public expenditures/GDP and revenues/GDP, which has not been previously documented in the literature. Finally, I determine that Norway, Finland, Denmark, Sweden, Canada, Portugal, and Austria exhibit sustainable fiscal policy during the sample time period, whereas the United States, Italy, France, Netherlands, United Kingdom, Japan, and Spain have unsustainable fiscal practices during the sample time period. The sample period is 1974-2010 for most nations, with the exception of Portugal and France, which begin in 1977 and 1978, respectively, due to data limitations.

In Sections II and III, the fiscal sustainability literature is reviewed with emphasis on the evolution towards multicointegration and its empirical derivation, as well as an explanation of the practical limitations of this framework for surplus countries. In Sections IV and V, the data is described and a five-step methodology is executed: tests to confirm the data is appropriate for multicointegration, regression between stock-flow variables, determining presence of multicointegration or cointegration, applying sustainability criteria to assess countries' fiscal practices, and contextualizing results through country case studies. Finally, some concluding remarks for further policy are provided. Empirical results from Leachman et al. (2005), a study measuring fiscal sustainability from an earlier sample period, are provided in the Appendix.

II. Literature Review

The literature on fiscal sustainability is expansive, reflecting both the difficulty and the importance of assessing nations' fiscal practices. Burnside (2005) provides a review of the theoretical underpinnings and the empirical tools in fiscal sustainability analysis. Both the theoretical and empirical literature often examine the government's lifetime budget constraint. The lifetime budget constraint

states that the government's debt obligations are equal to the present value of future primary surpluses and seignorage revenue. Sims (1994), Woodford (1995), and Cochrane (2001, 2005) derive theoretical results of the lifetime budget constraint on price levels and monetary or fiscal policy in closed economy models. Dupor (2000), Daniel (2001), and Corsetti and Mackowiak (2005) also analyze theoretical implications of fiscal models on currency crises and exchange rates for open economies.

To expand the theoretical inquiries, the lifetime budget constraint has been tested through various empirical papers. Hamilton and Flavin (1986), Wilcox (1989), and Kremers (1989) have empirically tested the budget constraint for the United States, but the studies arrive at contradicting results. Cointegration between spending and revenue streams, which requires a nonstationary relationship between spending and revenue, is a standard approach for testing whether the government adheres to its lifetime budget constraint. Trehan and Walsh (1988, 1990), Hakkio and Rush (1991), Haug (1991), Ahmed and Rogers (1995), Smith and Zin (1988), and Leachman (1996) have empirically tested for cointegration in the United States, Canada and the United Kingdom, and results are sometimes contradicting in these studies as well.

The seminal work of Barro (1979, 1989) on tax smoothing, that spending is financed by debt or taxes, so optimal debt is determined by minimizing the present value of tax distortions, spawned an enormous literature on the political and institutional variables that are important in understanding public finance. Cukierman and Meltzer (1989) expand the tax smoothing model to find that the variation in wage-earning ability is related to debt accumulation because of redistributive policies. Alesina and Tabellini (1990) reject the tax smoothing model, noting that debt issuance is strategic by policymakers, and due to the uncertainty over who will be appointed in the future, there is a bias towards deficits. Alesina and Perotti (1995) support the bias towards budget deficits and provide more explanations, such as the "fiscal illusion" of voters underestimating future tax burdens and the oversupply of public projects

due to representatives overestimating the benefits to their own districts relative to the national financing costs.

Not only did the political economy literature note the bias towards budget deficits, but Bohn (1995) also noted the importance of the GDP growth rate in affecting stochastic discount factors such that certain countries could run persistent deficits due to high economic growth. He formalized the limitations of traditional cointegration approaches by showing that the previous deterministic models did not capture the transversality condition that can be met through modeling in a stochastic setting. Correct discounting is critical in economies where the rate of growth has been higher than the real interest rate. Such an economy can sustain persistent deficits because high rates of economic growth lower the stochastic discount factor, diminishing the debt burden. Bohn (1998) outlines and tests for a corrective mechanism in the budgeting process that enables an economy to sustain balance regardless of whether the rate of economic growth is above or below the real interest rate on sovereign debt. Therefore, multicointegration has replaced simple cointegration studies to accommodate the corrective policy mechanism (Leachman et al., 2005).

Leachman et al. (2005) provide formalization of the corrective policy response criteria, which delineate that deficit countries should have increasing revenue responses (or decreasing expenditure responses) to debt buildup while surplus countries should have decreasing revenue responses (or increasing expenditure responses) to savings buildup. They also investigated the presence of multicointegration, which assesses two cointegration relationships: the first between the flow variables of spending and revenue, and the second between the flow variable of revenue and the stock variable of debt. These conditions jointly characterize multicointegration between government spending and revenue and, in conjunction with appropriate policy responses, indicate fiscal sustainability in all states of nature. It is important to underscore that multicointegration and the corrective policy response ensure

that a country's budgeting strategy is sustainable even when the rate of economic growth falls short of the real interest rate on sovereign debt. Leachman et al. (2005) test 15 OECD countries (similar but not identical to the 15 countries studied here) for a sample period of 1960-98 and they find that only Norway and the United Kingdom exhibited fiscal processes consistent with the revised criteria.

After the Leachman et al. (2005) study, other scholars have been able to utilize its formalization of criteria for sustainability in several applied papers. Escario et al. (2012) is a recent example of a study that utilizes the Leachman et al. criteria. They apply it to understanding recent data in Spain, with their time series ranging from 1857-2000, with an emphasis on using the multicointegration methodology to analyze Spanish long-run fiscal sustainability. However, they also adjust the model to fit the recurrent use of monetization. They find that seignorage was essential in guaranteeing long-run government solvency, concluding that the current deprivation of monetization, due to the Eurozone, is linked to the current crisis.

I also employ much of the Leachman et al. framework to empirically test an updated sample of 14 OECD countries. However, I depart from previous frameworks in my criteria's assessment of surplus countries. Rather than expecting multicointegration or even corrective policy responses, I discuss (through practical case studies) that surplus countries may have extremely valid reasons for building up savings. In addition, I augment the literature by providing an unusual example of a negative relationship between spending/GDP and revenue/GDP, which has not been discussed previously. Due to updating the sample period, I also find very different empirical results compared to any past studies.

III. Theoretical Context

In a theoretical framework, fiscal sustainability involves forecasting and expectations of the future. This is because sustainability is a condition of the government's intertemporal budget constraint:

in the long run, sustainability requires that the discounted sum of expected government expenditures cannot exceed the discounted sum of expected revenues. This means it is possible for a government to engage in prolonged periods of large government deficits and still be sustainable, but the key requirement is that future surpluses must compensate past deficits.

The definition of fiscal sustainability rests on the intertemporal budget constraint, so in reality sustainability is unknown because future budgeting is unknown. Cointegration and multicointegration techniques are employed as a result of this limitation because they examine long-run relationships between public revenue and expenditure to determine whether the current trends are at least on a sustainable path. Cointegration occurs when the revenue and expenditure series share a common stochastic drift. In other words, spending and revenue series are cointegrated if they are individually I(1) but some linear combination of them is I(0). As discussed in the literature review, multicointegration has replaced cointegration as the necessary test of fiscal sustainability. Multicointegration requires two cointegrating relationships. The first cointegrating relationship required is between the flow variables of spending and revenue. In equation (2), spending = ΔY_t and revenues = ΔX_t and they are cointegrated if Z_t is I(0) because it is a linear combination of them.

(2) $$Z_t = \Delta Y_t - K_0 \Delta X_t$$ where Z_t is I(0) if ΔY_t and ΔX_t are cointegrated

K_0 captures whether a country accumulates deficits or surpluses. Z_t is the residual term, and this means that the equation can be conceptualized as $\Delta Y_t = K_0 \Delta X_t + Z_t$. If a nation accumulates higher spending than revenue, it will have a slope greater than 1 and is considered a deficit nation, whereas a nation that accumulates higher revenues than spending will have a slope less than 1 and is considered a surplus nation. If the cointegration holds true, Z_t is I(0) and it can be accumulated into an I(1) series, S_t, represented in equation (3).

(3) $S_t = \sum_{j=1}^{t} Z_j$ is I(1) because it is the accumulation of Zt

The second cointegrating relationship required for multicointegration is between the accumulated residual of the first cointegrating relationship S_t which represents accumulated deficits (debt), and either of the flow variables. In equation (4), this is accomplished by et being I(0) through some linear combination of the stock and flow variables. In equation (4), revenues are shown as the covariate, but either flow variable (revenues or expenditures) can be used to establish the stock and flow cointegrating relationship.

(4) $$e_t = S_t - K_1 \Delta X_t \text{ where } e_t \text{ is I(0) if } S_t \text{ and } \Delta X_t \text{ are cointegrated}$$

The second round pertains to how the flow variables are related to debt (or savings), so this second cointegrating relationship measures the appropriateness of policy responses to buildups of debt (or savings). Conceptualizing equation (4) as $S_t = K_1 \Delta X_t + e_t$, a corrective policy response for deficit nations is $K_1 > 0$ because that represents a positive trend between debt and revenues. Surplus countries should lower revenues in conjunction with increases in savings (according to corrective policy response literature), and since S_t represents the accumulated savings for a surplus nation, this would require $K_1 < 0$.

Engsted et al. (1997) find favorable statistical properties when the two levels of cointegration are estimated simultaneously. Equation (2) is first accumulated, which is shown below in equation (5):

(5) $$\sum_{j=1}^{t} Z_t = \sum_{j=1}^{t} \Delta Y_t - \mathrm{K}_0 \sum_{j=1}^{t} \Delta X_t$$

The relation is equation (3) can then be substituted into equation (5), written below in equation (6):

(6) $$S_t = \sum_{j=1}^{t} \Delta Y_t - \mathrm{K}_0 \sum_{j=1}^{t} \Delta X_t$$

Finally, equation (6) is substituted into equation (4) and accumulated series are rewritten such that $\sum_{j=1}^{t} \Delta Y_t = Y_t$ and $\sum_{j=1}^{t} \Delta X_t = X_t$. and a constant, α_0, and a time trend, $\alpha_1 td$, are added to account for the possibility of deterministic trends. The one-step specification is written below in equation (7):

(7) $$Y_t = K_0 X_t + K_1 \Delta X_t + \alpha_0 + \alpha_1 td + e_t$$

To review, Y_t represents the accumulated expenditure stream, X_t represents the accumulated revenue stream, and td = trend, which can be linear or quadratic. ΔX_t is the first difference of the accumulated revenue series, meaning it is simply the revenue series.

Multicointegration leads to a nonstationary e_t in equation (7), but this alone is insufficient for sustainability. In the Leachman et al. sample, the United States was multicointegrated, but debt accumulation was accompanied by declines in government revenue. Bohn (1995) and Leachman et al. (2005) highlight the importance of corrective policy response criteria, which must be fulfilled in addition to multicointegration.

- If $K_0 > 1$, sustainability requires $K_1 > 0$.
- If $K_0 < 1$, sustainability requires $K_1 < 0$.

As discussed, K_0 captures whether a country accumulates deficits or surpluses. If spending accumulates more than revenue, then the slope of the relationship will be greater than 1, which is characteristic of deficit countries. The opposite rationale derives why $K_0<1$ indicates a surplus country. K_1 is the relationship between revenue flow and stock of debt. If K_1 is positive, then as debt increases, revenue also increases, which is a favorable policy response for deficit countries. The corrective policy response criteria can also be summarized as the following: deficit countries must increase revenues to accommodate rising levels of debt, while surplus countries must decrease revenues to accommodate rising levels of public sector wealth.

I argue that the current theories provide a comprehensive framework for assessing sustainability if a nation is running persistent deficits: both multicointegration and fulfillment of the corrective policy response criteria are required. However, these theories lack a practical discussion of how to assess countries with persistent surpluses, especially when they do not fulfill the sustainability criteria. Section V. will provide examples of countries that do not fulfill either the multicointegration or corrective policy

response criteria, but are classified as sustainable because of their accumulations of surpluses, and the rationale behind this classification will be further discussed in a case study of Norway.

IV. Data

The OECD Factbook Statistics database was used to obtain spending and revenue series, as a percent of GDP, for 15 OECD economies: Austria, Belgium, Canada, Denmark, Finland, France, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom, and USA. In order to be included in the sample, countries were required to have at least 30 data observations, which excluded many countries, such as Germany and Poland. In addition, data was not taken before 1974 due to the major monetary re-structuring, the Bretton Woods system, during the early 1970s. The OECD Factbook Statistics reported the data as from consolidated government figures of revenue and spending in real terms and the data was already reported as percentages of real GDP, as recommended by Bohn (1995, 1998) and Ball et al. (1998).

V. Empirical Specification

My empirical method requires five steps: verifying that the spending and revenue series contain unit roots, regression estimation, determining presence of multicointegration or cointegration, applying sustainability criteria to assess countries' fiscal practices, and contextualizing results through country case studies.

Verifying unit roots in the spending and revenue series

The multicointegration analysis employed in this project requires that the flow variables (Revenue/GDP and Expenditure/GDP) are nonstationary, which is equivalent to having a unit root. The Augmented Dickey-Fuller (ADF) Test is used to verify that the series are both nonstationary. Because

the null hypothesis of the ADF Test is that a unit root exists, insignificant test statistics are needed to continue with multicointegration analysis. Table 1 shows the results of the ADF test on the Revenues/GDP and Expenditures/GDP series. Using a 5 percent significance level, Belgium is rejected from the further multicointegration analysis because it appears to have stationary series for both revenue and expenditure.

Regression estimation

As mentioned in the Theoretical Framework, Engsted et al. (1997) developed the following one-step multicointegration equation:

(7) $$Y_t = K_0 X_t + K_1 \Delta X_t + \alpha_0 + \alpha_1 td + e_t$$

where Y_t represents the accumulated expenditure stream, X_t represents the accumulated revenue stream, and td = trend, which can be linear or quadratic. ΔX_t is the first difference of the accumulated revenue series, meaning it is simply the revenue series. K_0 captures the relationship between the flow variables of spending and revenue and K_1 captures the relationship between those flow variables and the stock variable of their accumulations. Equation (7) was estimated for each country, and the structure of the time trend (whether it is absent, linear or quadratic) was determined solely based on the overall significance of the estimation in order to maximize the efficiency of the estimation. Table 2 displays the regression results. Significance for K_0 is reported with respect to a null hypothesis of $K_0 = 1$ because the designation of deficit or surplus country is done with respect to 1. From these results, the three surplus nations are apparent because they have $K_0<1$: Norway, Denmark and Finland. Norway in particular actually has a negative value, which will be explained in a case study discussion. The remaining 11 countries are deficit nations, but the magnitudes of their K_0 values are insightful in characterizing the magnitude of their deficit accumulations, and more importantly, the sign and magnitude of their K_1

TABLE 1
ADF STATISTICS FOR SPENDING/GDP AND REVENUE/GDP

Country	Spending/GDP	Revenue/GDP
Austria	-3.114	-1.573
Belgium	-3.627**	-3.780**
Canada	-2.004	-0.066
Denmark	-2.164	-1.194
Finland	-1.835	-2.882
France	-2.388	-2.942
Italy	-2.066	-1.280
Japan	-3.378*	-1.757
Netherlands	-2.559	-2.996
Norway	-1.950	-2.541
Portugal	-2.591	-2.412
Spain	-2.070	-1.042
Sweden	-2.574	-3.276*
United Kingdom	-0.433	-1.777
USA	-1.131	-1.656

NOTE.—Critical values for the ADF statistic vary by sample size and are drawn from the MacKinnon distribution function for unit root test statistics. * indicates $\alpha = 0.10$ significance level. ** indicates $\alpha = 0.05$ significance level. *** indicates $\alpha = 0.01$ significance level.

values are imperative in describing the appropriateness of their policy responses to debt. For example, the United Kingdom is not building a large deficit (K_0=1.101), but its response it not corrective (K_1= -0.815). The deficit accumulation for Portugal is similar to that of the United Kingdom (K_0=1.094), but its response is one of the highest (K_1=2.857) which is a good sign for sustainability. However, these results alone do not determine sustainability; the following sections will build on these estimations in order to complete the analysis.

Tests for Multicointegration or Cointegration

To continue the sustainability analysis, the regression results must be used to test for the presence of multicointegration within fiscal practices. There are two methods for testing

multicointegration: ADF tests on regression residuals or the Johansen Cointegration Test. Both tests are completed for the analysis because each test alone faces limitations.

TABLE 2
MULTICOINTEGRATION COEFFICIENTS

Country	K_0	K_1	Con	t	t^2
Austria	1.217***	1.638***	-81.354***	-2.47**	--------
Canada	1.074***	7.228***	-271.481***	--------	--------
Denmark	0.998	4.132***	-184.272***	--------	--------
Finland	0.981***	-1.380**	35.225	--------	--------
France	1.229**	0.236	-23.569	-7.992	--------
Italy	1.460***	2.922***	-97.816***	-5.170	-0.219***
Japan	1.122***	-1.654	41.520	---------	--------
Netherlands	1.507***	-0.725***	10.849	22.078***	--------
Norway	-0.609***	-5.889***	319.753***	83.255***	--------
Portugal	1.094***	2.857***	-63.551***	---------	--------
Spain	1.452***	-2.259***	38.605***	5.848**	-0.183***
Sweden	1.028***	0.298	-30.172	--------	--------
United Kingdom	1.074***	-0.815	42.596*	--------	--------
USA	1.101***	1.009	-30.797	--------	--------

NOTE.— Based on the equation: $Y_t = K_0X_t + K_1 \Delta X_t + \alpha_0 + \alpha_1 td$, where Y = accumulated spending ~I(2) and X = accumulated revenues ~I(2). * indicates $\alpha = 0.10$ significance level. ** indicates $\alpha = 0.05$ significance level. *** indicates $\alpha = 0.01$ significance level. **Significance for K_0 is reported with respect to a null hypothesis of $K_0 = 1$.**

The ADF approach requires testing the residual e_t from equation (7), the one-step regression equation developed by Engsted et al. Multicointegration is indicated by a stationary e_t residual series (statistically significant ADF statistic). Table 3 presents the results of the ADF test on the residuals from equation (7). The Johansen test was also employed to check for multicointegration because it was directly designed for testing cointegration between I(1) series. The Johansen Test returns the rank (number) of cointegrating vectors, but one of the important limitations of the Johansen Test is that it sometimes fails to determine the rank because no particular rank is statistically significant. For example, the Johansen Test applied to Austria from 1974-2010 cannot determine whether the number of cointegrating vectors is 0, 1, or 2. The results of the Johansen Test are reported in Table 3. Due to the

limitations and sometimes opposing results of the ADF and Johansen Test, I have chosen a methodology where multicointegration in either test is coded as multicointegration. Portugal was multicointegrated by ADF but not Johansen, and Sweden was multicointegrated by Johansen but not by ADF, and both were coded as "Multicointegrated" in my methodology. The following countries were found to exhibit multicointegration: Austria, Canada, Denmark, Portugal, and Sweden.

The non-multicointegrated nations still have the possibility of exhibiting simple cointegration between spending and revenue, which would be indicated by a Johansen rank of 1 or a statistically significant ADF test of the residual from a simple regression of Spending versus Revenues, as in equation (8).

(8) $Z_t = \Delta Y_t - K_0 \Delta X_t$ where Z_t is I(0) if ΔY_t and ΔX_t are cointegrated

As with multicointegration, the methodology for determining cointegration used here is to accept it if

TABLE 3

MULTICOINTEGRATION AND COINTEGRATION RESULTS

Country	ADF for Multicoint.	Johansen Rank	ADF for Coint.	Result
Austria	-3.099**	----	-4.057***	Multicointegrated
Canada	-2.793*	----	-1.836	Multicointegrated
Denmark	-2.614*	----	-2.342	Multicointegrated
Finland	-1.287	1	-2.721*	Cointegrated
France	-1.746	----	-1.754	Neither
Italy	-2.189	0	-1.879	Neither
Japan	-0.300	0	-2.244	Neither
Netherlands	-2.473	1	-4.206***	Cointegrated
Norway	-1.925	0	-1.840	Neither
Portugal	-3.438***	0	-3.338**	Multicointegrated
Spain	-1.597	----	-1.649	Neither
Sweden	-1.168	2	-2.126	Multicointegrated
United Kingdom	-1.095	0	-1.223	Neither
USA	-0.796	0	-0.621	Neither

NOTE.— Critical values for the ADF statistic vary by sample size and are drawn from the MacKinnon distribution function for unit root test statistics. * indicates $\alpha = 0.10$ significance level. ** indicates $\alpha = 0.05$ significance level. *** indicates $\alpha = 0.01$ significance level.

cointegration of spending and revenue is supported by either the Johansen rank or the ADF cointegration test. Table 3 presents results from the ADF multicointegration test, the Johansen rank, the ADF cointegration test, and the final result based on the methodology described.

Sustainability Criteria and Ranking

As described in the Literature Review and Theoretical Framework, the most updated theories require both multicointegration and a corrective policy response in order for a country's fiscal practices to be considered sustainable. The corrective policy response criteria are repeated here:

- If $K_0 > 1$, sustainability requires $K_1 > 0$.
- If $K_0 < 1$, sustainability requires $K_1 < 0$.

This corrective policy response can also be summarized as the following: deficit countries must increase revenues to accommodate rising levels of debt, while surplus countries must decrease revenues to accommodate rising levels of public sector wealth.

However, I question the practicality of past criteria for surplus countries. There are plausible reasons why a country should implement fiscal policy that widens surpluses, instead of contracting them. If a surplus is widening due to a transient source of government revenue, such as oil revenue, it is preferable to build up savings currently and later spend them when the windfall source of revenue is depleted. For countries where there may be an issue of temporary revenue windfall, it is preferable to incur large savings rather than be perfectly balanced because a current balanced budget would be more likely to lead to a future unsustainable deficit (or difficult expenditure cuts) when the source is depleted. As a result surplus nations are automatically considered to be sustainable in this paper. The complete sustainability criteria are as follows:

- Persistent surpluses ($K_0<1$) are considered sustainable.
- If deficits are persistent ($K_0>1$), sustainability requires both multicointegration and a corrective policy response ($K_1 > 0$), which is consistent with past literature.

Table 4 summarizes the results of applying the sustainability criteria to the 14 OECD countries. All surplus countries were designated as sustainable, which includes Denmark, Norway and Finland. Deficit countries were classified using the multicointegration and corrective policy response frameworks. Canada, Sweden, Portugal and Austria were classified as sustainable because despite deficit accumulation, they exhibited both multicointegration and a positive revenue response to debt. Three countries—USA, Italy, and France—also exhibited the positive revenue responses to debt, but they had no cointegrating vectors and were thus unsustainable. Netherlands, United Kingdom, Japan, and Spain all had a decreasing relationship between revenue and debt buildup, and were therefore unsustainable. Netherlands interestingly was cointegrated, but this is of little value if the policy response is incorrect.

TABLE 4

SUSTAINABILITY ASSESSMENT

	Persistent deficits ($K_0 > 1$)	**Persistent surplus ($K_0 < 1$)**
Multicoint. AND corrective policy	**SUSTAINABLE** Canada, $K_1 > 0$, multicointegrated Sweden, $K_1 > 0$, multicointegrated Portugal, $K_1 > 0$, multicointegrated Austria, $K_1 > 0$, multicointegrated	**SUSTAINABLE**
Not Multicoint. OR not corrective policy	**UNSUSTAINABLE** USA, $K_1 > 0$, neither Italy, $K_1 > 0$, neither France, $K_1 > 0$, neither Netherlands, $K_1 < 0$, cointegrated United Kingdom, $K_1 < 0$, neither Japan, $K_1 < 0$, neither Spain, $K_1 < 0$, neither	**SUSTAINABLE** Denmark, $K_1 > 0$, multicointegrated Norway, $K_1 < 0$, neither Finland, $K_1 < 0$, cointegrated

Further Discussion

In order to contextualize these results, it is useful to look for departures from the results found in an earlier sample period by Leachman et al. (2005). I have included their results in the Appendix. Two of the most dramatic changes are present in the fiscal practices for Canada and the United Kingdom. I have assessed Canada as fiscally sustainable, because though it ran overall deficits, Canada exhibited multicointegration and also had the appropriate policy response of decreasing deficits in response to debt buildup. However, in the Leachman et al. sample, which captured 1960-98 (as opposed to 1974-2010), Canada failed every criterion: it had widening deficits and did not exhibit even simple cointegration. On the other hand, I have assessed the United Kingdom as fiscally unsustainable, and it failed every criterion: it had widening deficits and did not exhibit even simple cointegration. This is a dramatic change compared to the Leachman et al. sample period in which it was fiscally sustainable (multicointegrated and decreasing deficits). In the Leachman et al. study, of 15 countries tested, the United Kingdom was one of only two countries determined to fulfill all of the sustainability criteria (in addition to Norway), so it is particularly surprising that its fiscal practices have since declined. Norway is still found to be fiscally sustainable as in the past sample period, but it still presents a particularly interesting case study in this paper. In my updated sample period, Norway fails to be multicointegrated and it also fails to have a corrective policy response for its surplus issue. However, by my revised criteria I have allowed all surplus countries to be assessed as sustainable. Norway demonstrates this practicality especially well through its current windfall of oil profits, which are partly siphoned into government revenues through Norway's model of state capitalism. Because this source of wealth is a limited resource (oil reserves), it is essential that Norway builds its savings (and therefore widens surpluses) to prepare for a future without oil. Norway is also fascinating in my study because of its negative K_0 value, which I will interpret in a later section and which has yet to be seen in any previous

literature. The United States presents an interesting example because it changes from being multicointegrated to not even simply cointegrated, although in both studies it is characterized as unsustainable. In Leachman et al, the USA fails the coefficient corrective mechanism criteria, whereas in my study, the coefficients are appropriate but the lack of even simple cointegration prevents a sustainable assessment. Finally, the Netherlands is also a very intriguing case study; it is an example of how the cointegration tests can pass, but alone do not ensure sustainability. Netherlands is cointegrated, but this is of no real beneficial quality, because Netherlands builds up deficits and shows no revenue response.

Norway

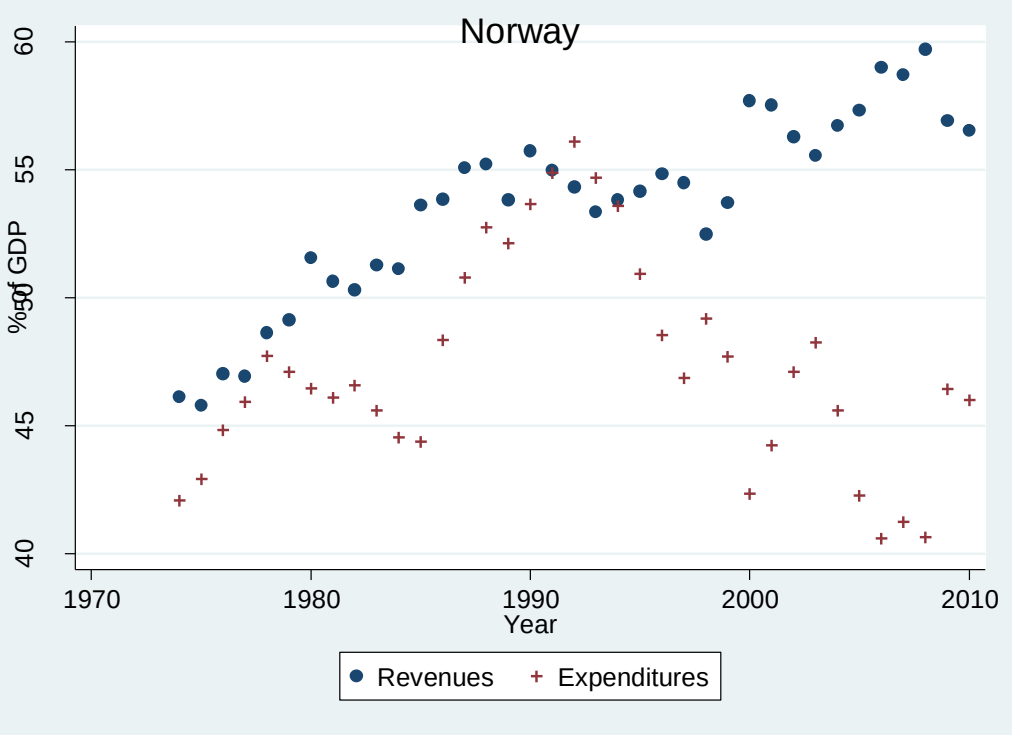
Norway, Finland and Denmark are categorized as sustainable because of their persistent surpluses. This result illustrates the divergence from multicointegration and corrective policy response sustainability theory: Norway and Finland would be unsustainable because they lack multicointegration and Denmark would be unsustainable because its policy response to surplus is increased revenue. In addition to lacking cointegration, Norway also increases revenue in response to surplus, though this is difficult to notice because K_1 is negative. Norway has a negative K_0, making it the only country that has a negative correlation between the flow variables: as revenue goes up, spending goes down. Figure 2 verifies that as time increases, the latter occurred: revenue increased while spending decreased. That makes K_1 easier to interpret: it represents a negative relationship between debt accumulation and revenue response. The widening surpluses (evidenced by negative K_0) indicate that debt decreased over the time period, so the revenue response increase over the time period.

The current theory would characterize this behavior—persistent surplus with increases in revenue—as unsustainable. However, a discussion about Norway's economy shows that rather,

Norway's practices exhibit sustainability. Given the importance of a strong GDP to public finance, Norway displays consistent high levels of GDP per capita. Norway today is one of the wealthiest nations in the world, measured both by GDP per capita and in capital stock. On the United Nations Human Development Index, Norway has been among the three top countries for several years, and in 2012 it was ranked 1st (UNDP).

Norway is particularly prosperous due to its huge stocks of natural resources combined with a skilled labor force. Norway is a developed mixed economy, where the state owns large stakes in many private companies, including oil companies. Norway is the world's eighth largest oil exporter, and this contributes significantly to government revenues. Petroleum currently accounts for 30 percent of government revenues. Therefore the large and increasing surpluses in Norway are unlikely to remain so once natural petroleum reserves run out. Figure 3 shows the high importance of oil in the Norwegian economy.

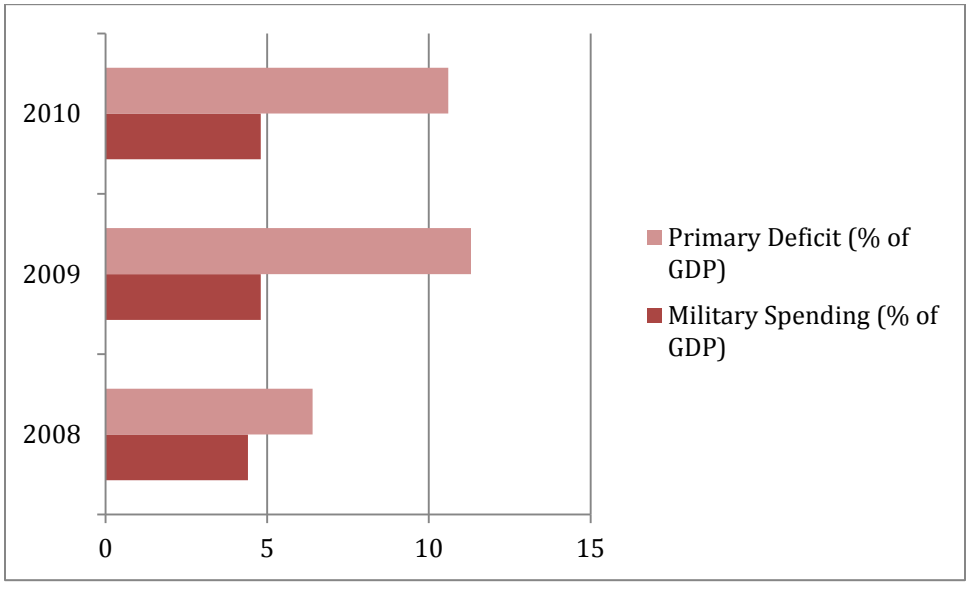
FIGURE 2
NORWAY REVENUES/GDP AND EXPENDITURES/GDP, 1974-2010



The government may be allowing these massive revenue intakes because they know that they are transient. In fact, the Norwegian government has shown that it is aware of its need to prepare for a future when oil runs out. In 1990 they established a sovereign wealth fund, known as PFG, to prepare for their post-petroleum future, which is considered by some to be one of the best-run sovereign wealth funds in the world ("Norway: The Rich Cousin"). Therefore, not only is the increasing surplus buildup a sustainable practice in Norway, but the opposite (decreasing the surplus buildup) would actually be unsustainable given the post-oil future. This is even more important because the government heavily subsidizes public benefits like sickness and disability benefits, minimum guaranteed pensions, health care, unemployment insurance. Given the transient source of revenue, maintaining these public expenditures requires accumulation of savings (or higher GDP growth).

FIGURE 3

NORWAY IMPORTANCE OF OIL, 2008-2010



Source: World Bank

In the future, health care and retirement spending are expected to increase sharply, so a large portion of the petroleum revenues should invested into PFG to avoid a substantial fiscal tightening later.

Norwegian petroleum revenues are directed into PFG and the capital is invested abroad to avoid fluctuations of the mainland economy. Transfer from the fund to the state budget is set at a low number (4 percent) to ensure gradual and sustainable phasing in of petroleum revenues. In addition to PFG, government has taken several additional measures to ensure future sustainability. Though not a member of the European Union (EU), Norway has joined the European Free Trade Association, which gives Norwegian companies access to European markets. The government is also encouraging new "mainland" industries that would be internationally competitive, like the formation of nine "centers of expertise," including Oslo Cancer Cluster (Aldridge 2008).

Canada

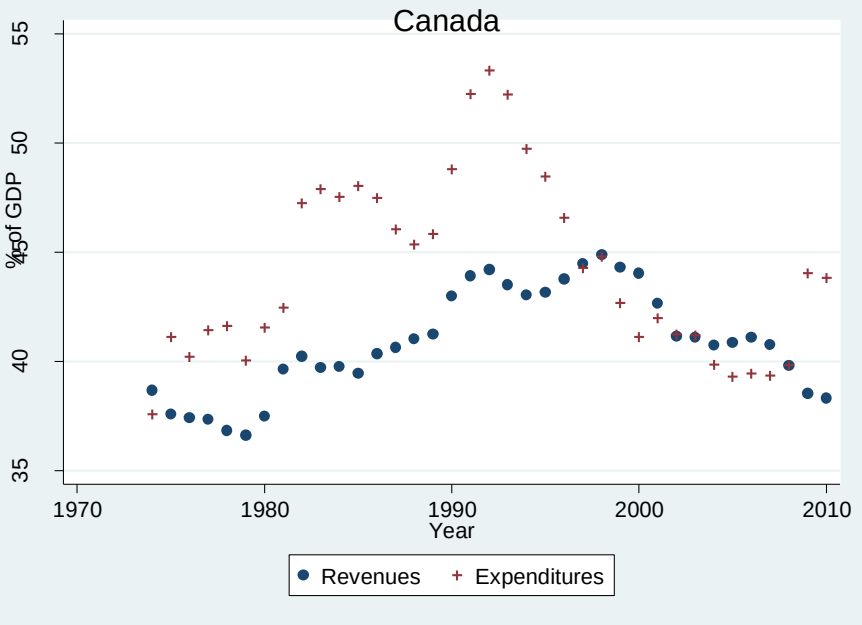
Canada, Sweden, Portugal, and Austria are the group that under past frameworks would be the only countries considered sustainable. They are multicointegrated and have the appropriate corrective policy responses. Canada in particular has become dramatically more sustainable since the Leachman et al. results in which it was neither multicointegrated nor had the correct policy response. In Figure 4, a dramatic shift is visible in the mid-1990s: the difference between spending and revenue decreases, and after this shift, most years are either balanced budgets or surpluses. Canada's method of fiscal restructuring was through substantial cuts in government spending, rather than large tax increases. The 1995 budget called for six to seven dollars in expenditure cuts for every dollar of increased taxes. The Canadian government cut defense, unemployment insurance, transportation, business subsidies, aid to provincial governments, and began to transform the Canada Pension Plan from a pay-as-you-go structure to a partially funded system (Henderson and Anderson). As a result of these, Canada's government debt burden is among the lowest in the Group of Eight (G8) nations.

The diversified nature of the Canadian economy also bodes well for its future sustainability. Like many developed countries, the service industry is a dominant sector of the Canadian economy.

However, unlike many developed countries, primary sectors like logging and oil are also important industries in Canada. In addition, its manufacturing and commercial fishing industries are also important. Canada, like Norway, is one of the few developed countries that is a net exporter of oil and natural gas. With its vast Athabasca oil sands, also known as "dirty oil," Canada has the third largest reserves of oil in the world. In addition, Canada has considerable mineral resources of coal, copper, iron ore, and gold. Export, especially of its vast natural resources, is a significant part of Canadian economy.

Though Canada exhibits current sustainability and a diverse economy, like many other developed welfare states, the healthcare system is a significant economic factor. Because most aspects of the healthcare insurance system are financed by provincial government revenues and due to the rising costs of healthcare, healthcare has grown to become the largest component of Canadian provincial budgets. The growing costs of social expenditure, especially health, are one potential threat to future sustainability trends. Long term sustainability of the mining and petroleum industries are also important concerns; however, large discoveries of new reserves continue to be made.

FIGURE 4
CANADA REVENUES/GDP AND EXPENDITURES/GDP, 1974-2010



Netherlands

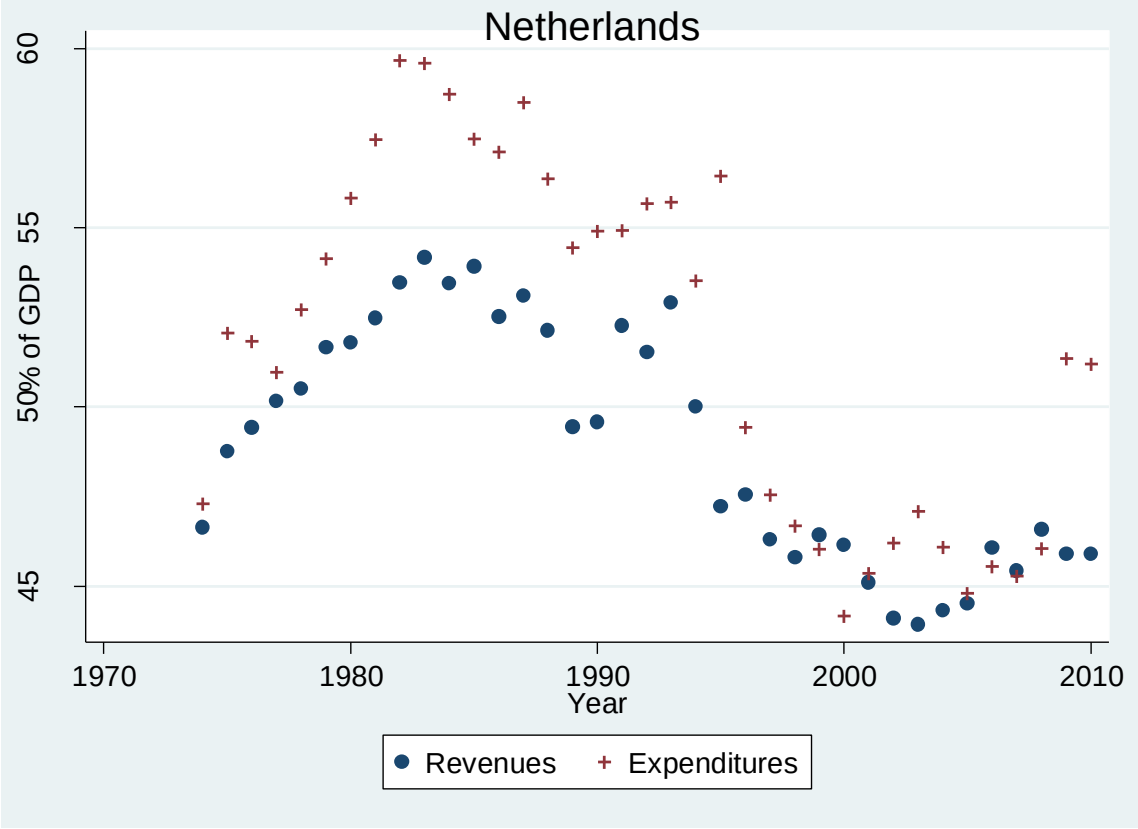
The Netherlands was the only country that had persistent deficits and was characterized by simple cointegration. By both current theory and this paper's methodology, the Netherlands is unsustainable for its negative revenue response to debt buildup. Like Canada, the Netherlands appears to have a visible shift in stricter fiscal practice in the mid-1990s, and this could also be indicated by the presence of cointegration in this sample compared to no cointegration in the Leachman et al. sample period of 1970-98. The shift can potentially be explained by the political changes occurring in the Netherlands during the mid-1990s that resulted in greater conservatism. In fact, from 1994-2007, the Netherlands practice was to deliberately underestimate the next year's national income growth in order to dampen the growth of debt (van der Ploeg).

Since the financial sector is an important aspect of the Dutch economy, the 2008 global financial crisis, which was instigated by the housing collapse and aggressive sub-prime mortgage lending in the United States, and subsequent European debt crisis, has had severe negative repercussions for the Dutch economy. As a result, the government had to bail out several financial institutions. The recent credit crises in Europe have also led to the loosening of previously stern financial policies. This probably increased government expenditures, especially due to the bailout and slow economic growth. Unfortunately, though the economy has shown some signs of recovery since 2009, the Dutch economy is currently in recession again, making austerity measures even more difficult to implement.

However, the economic situation is not all bleak for the Netherlands. Based on GDP per capita, the Netherlands is one of the top 10 richest countries in the world. It is a desirable destination for foreign direct investment and is a European hub for transportation. In addition, the Netherlands boosts a highly mechanized agricultural sector that produces large surpluses for export. The Netherlands has also managed to maintain its AAA credit rating even as larger economies like the United Kingdom have not.

FIGURE 5

NETHERLANDS REVENUES/GDP AND EXPENDITURES/GDP, 1974-2010]



USA

Despite being unsustainable, the USA, France, and Italy at least exhibited positive revenue responses to their debt accumulation. More research is required, but this group as well as three countries ranked below them may illustrate the importance of political systems for attaining fiscal sustainability. The United States is the world's largest national economy and its GDP is about a quarter of the global GDP. It contains an abundance of natural resources, a well-developed infrastructure, and a highly productive workforce with high levels of research and capital investment. The majority of global currency reserves have been saved in U.S. dollars. Clearly, the United States economy has the strength

needed to generate greater growth and revenue, but due to political polarizations, it is difficult to implement the appropriate economic policies to accomplish a fiscally sustainable trend. However, the United States has improved its policy response since the Leachman et al. sample in which it had a negative revenue response. Figure 6 illustrates the period of surpluses during the end of the Clinton presidency, which was not captured by Leachman et al. However, the Bush era tax cut and the financing of the Iraq and Afghanistan wars coincided with a return to deficit spending. Figure 7 compares military expenditures with the overall primary deficit, both as percentages of GDP from 2008-2010 to show that military spending accounts for a significant part of government outlays.

FIGURE 6

USA REVENUES/GDP AND EXPENDITURES/GDP, 1974-2010

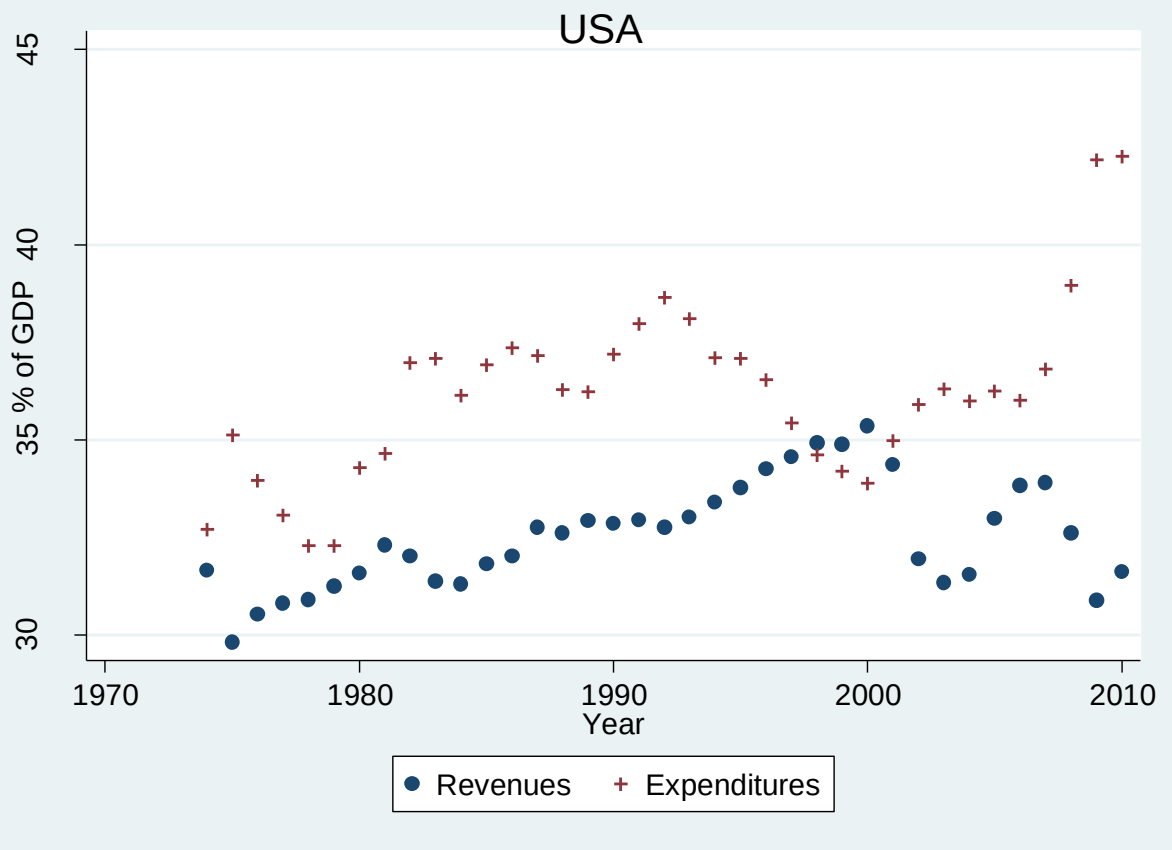
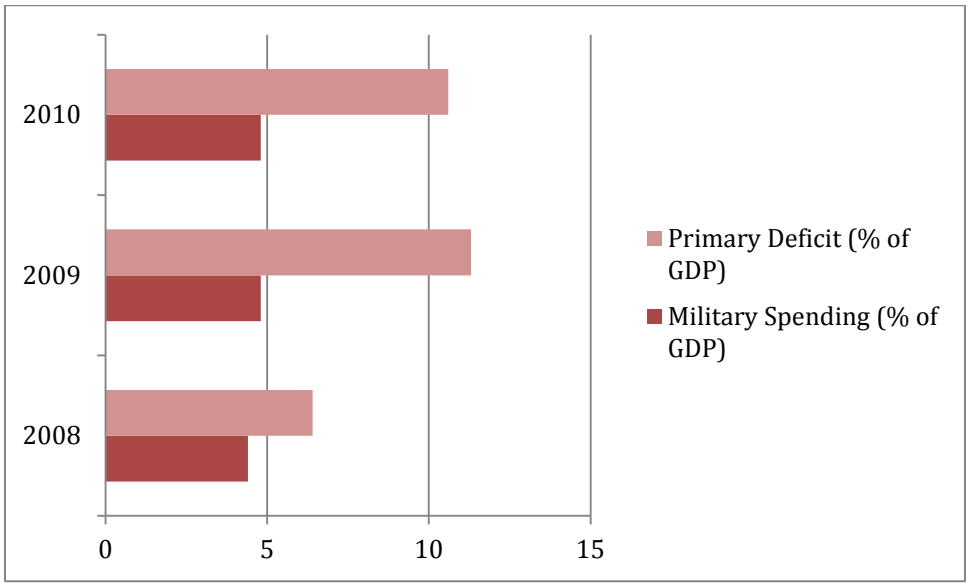


FIGURE 7

USA IMPORTANCE OF MILITARY SPENDING, 2008-2010



Source: World Bank

The United States' strategy to address the housing collapse of 2007-2008 and subsequent financial crisis from aggressive sub-prime lending was stimulus spending. This resulted in bail outs of several financial institutions and major companies in the automobile industry. The stimulus spending stabilized the financial sector and prevented the economy from going into depression, but significantly added to the public expenditures. The gridlock in Congress and its inability to arrive at a compromise solution for entitlement reform or revenue increases to reduce national debt resulted in the downgrading of the United States' credit rating from AAA to AA+ in 2011 by Standard and Poor's (S&P). The economic outlook is further exacerbated by the aging baby boomer generation and the associated increase in social security and health care costs.

United Kingdom

The United Kingdom is joined by Japan and Spain as failing all measures because of their lack of even simple cointegration and their negative revenue responses to debt accumulation. The United Kingdom is the most surprising because it was one of only two countries in Leachman et al.'s 15-country sample that was multicointegrated and sustainable (along with Norway). Despite its shift in sustainability assessments, the United Kingdom has not built up massive deficits, which is evidenced by the low K_0 value of 1.074. In addition, Figure 8 shows that the United Kingdom has experienced balanced budgets in the late 1980s and a couple years of surplus around the turn of the century.

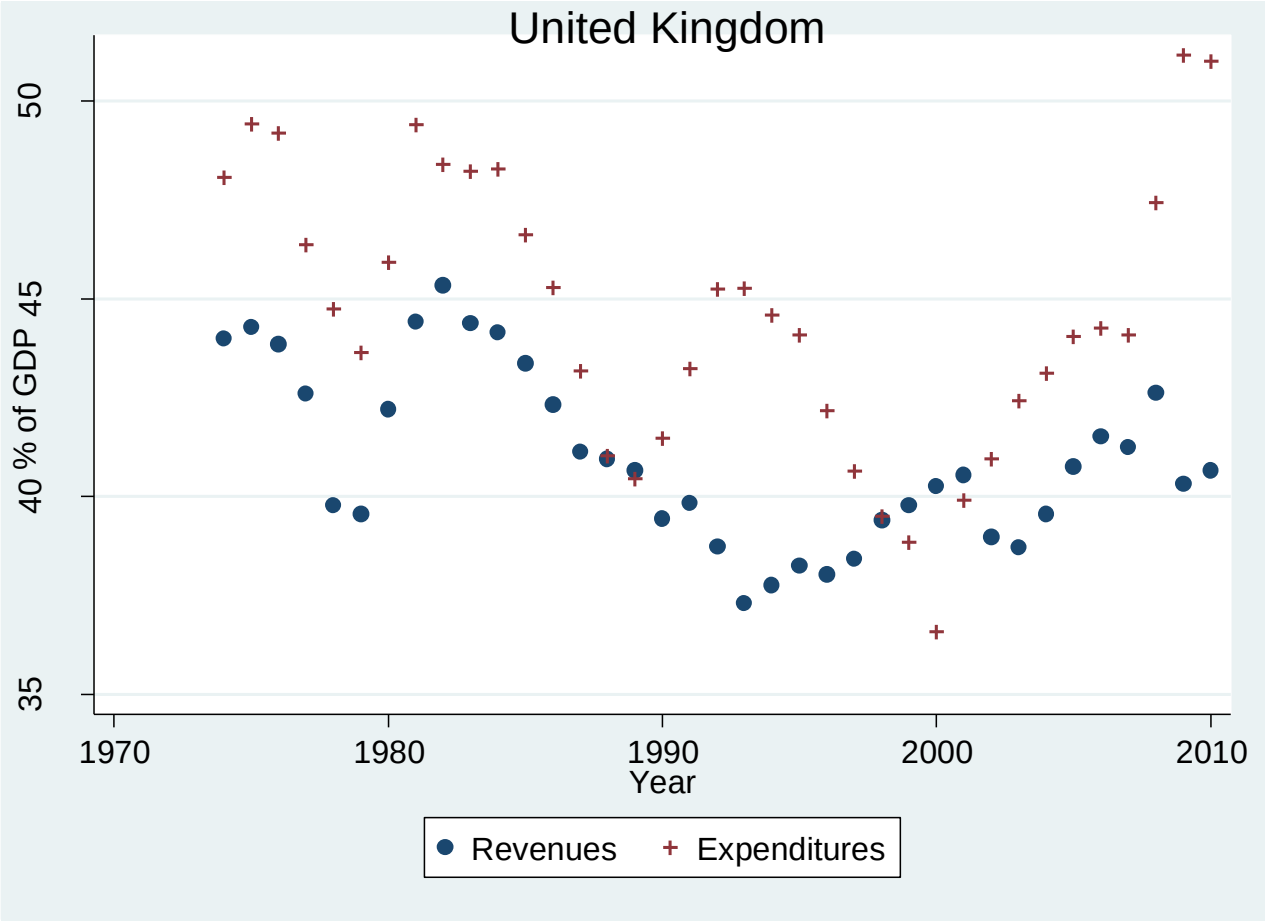
Spending in the United Kingdom has soared in recent years, which is visible in the final data points in Figure 8. Like the United States, the British government issued bailout packages to banks in 2008. However, the UK's general strategy has been public austerity rather than stimulus. The U.K. economy has been weak in recent years and has experienced a double dip recession between 2008 and 2012, resulting in a loss of its AAA credit rating from the Moody's credit rating agency. It is estimated that 14 million people were at the risk of poverty and the economic inequality in the U.K. is growing faster than in any other developed country. Larch (2012) is part of the political economy literature on budget deficits, and finds a positive relationship between income inequality and accumulation of budget deficits. This is consistent with the current situation in the United Kingdom, where economic inequality is rising and budget deficits are also rising. Larch suggests that this may be due to the government's role in providing welfare services and redistributive policies in times of economic inequality, which could both increase government expenditure and hamper economic growth.

Like other developed welfare states, the government provides health care and other social welfare programs which are increasing in cost. The United Kingdom is currently undergoing significant healthcare reform as a result of the increasing expenditure burden of its public healthcare system on the

government expenditures. This reform emphasizes competition between public and private providers of healthcare and reduces the number of bureaucratic staff officials involved in the provision of healthcare services.

FIGURE 8

UNITED KINGDOM REVENUES/GDP AND EXPENDITURES/GDP, 1974-2010



VI. Conclusion

This paper has employed the multicointegration framework to analyze the sustainability of fiscal practices for OECD economies. In addition, it has shown that these sustainability statuses can vary greatly over time: results changed dramatically compared with an earlier sample period conducted by

Leachman et al. in which "unsustainable" countries such as Canada and Finland are now among the highest ranked and countries like the United Kingdom moved from "multicointegrated and sustainable" to unsustainable and not even cointegrated.

The methodology used for Norway, Finland and Denmark suggested a more practical approach to assessing countries that have persistent surpluses. If series are not multicointegrated or do not have decreasing revenue responses, that could indicate a deliberate preparation for the future rather than government hoarding excess resources. Therefore, unlike theory suggests, multicointegration is not necessarily an appropriate goal for surplus nations that are deliberately preparing for future periods of less growth or less revenue. Similarly, the policy response coefficient does not need to be negative for these countries for the same reason. This paper also discussed the interpretation of a negative K_0, which, due to being an uncommon finding, had not been addressed in previous literature.

Policymakers can see the different approaches to fiscal practice inherent in this sample of OECD economies. The Scandinavian countries—Norway, Finland, Sweden, and Denmark—were all identified as sustainable. These are powerful examples that strong social safety nets and large public expenditures can be sustainable as long as revenue responds to debt buildup. On the other hand, Canada's dramatic fiscal reforms led to their fiscal sustainability through reducing public expenditures considerably. A limitation of multicointegration analysis is that it cannot give a semblance of causation in terms of what policies cause better fiscal sustainability. Even though causation cannot be determined, the different approaches to fiscal sustainability send an important message to policymakers: fiscal reform has no singular path. Clearly the Scandinavian and the Canadian approaches to fiscal practices are extremely different, yet both are sustainable.

In order to determine a better understanding of which fiscal practices are better suited for which nations, the next step should be analyses into political systems and into demographic profiles. As

discussed with the United States, the nature of political agreements in a practical setting is very important to what economic policies have the potential to succeed. In addition, demographic profiles need to be better understood. Nations with aging demographic profiles will require greater preparation for a future in which revenue generation will become more difficult, whereas countries experiencing population growth or in-migration are helped by their future ability to repay current debt burdens. Incorporating these political and development indicators will help to nuance the discussion such that policymakers and economists can transition from speculation about whether debt is unmanageable and instead transition to tailored policies that promote national and global wellbeing.

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Appendix

LEACHMAN ET AL. (2005) RESULTS

Country	K_0	K_1	Con	td	Vectors	Result
Belgium	1.5919	-5.3799	1.8813	-0.2532	None	Unsust.
Canada	1.6148	-1.1284	0.4436	-0.2147	None	Unsust.
Denmark	1.1759	-1.2633	0.4408	-0.1036	Coint.	Unsust.
Finland	1.3353	-2.2193	0.7282	-0.1740	Coint.	Unsust.
France	1.4315	-0.0000	-0.1622	-0.2118	Coint.	Unsust.
Greece	2.3904	-1.2673	0.4134	-0.3867	None	Unsust.
Italy	2.1484	12.7868	-3.4824	-0.6004	None	Unsust.
Netherlands^{++}	1.1844	0.6284	0.0311	0.0026	None	Unsust.
Norway^{++}	0.9572	-1.507	0.0649	-0.0014	Multicoint.	Sustainable
Portugal	1.2024	1.4386	-0.2424	-0.0703	None	Unsust.
Spain	1.1915	0.3217	-0.0704	-0.0655	Coint.	Unsust.
Sweden	1.4118	-2.7138	1.0663	-0.2332	Coint.	Unsust.
Switzerland	1.0336	0.6599	-0.1636	-0.0987	None	Unsust.
United Kingdom^{++}	1.2764	0.3082	0.0027	0.0009	Multicoint.	Sustainable
Unites States	1.5536	-1.2474	0.3395	-0.1530	Multicoint.	Unsust.

NOTE.— Based on the equation: $Y_t = K_0X_t + K_1 \Delta X_t + \alpha_0 + \alpha_1 td$, where Y = accumulated spending ~I(2) and X = accumulated revenues ~I(2). $^{++}$ indicates that the real spending and revenue per capita streams were used instead of spending and revenue as a percent of GDP.