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Fiscal Consolidations

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Abstract

I examine whether action-based fiscal consolidations are exogenous to contemporaneous GDP growth. Based on the narrative record, these fiscal consolidations had the primary objective to reduce a budget deficit. I find that temperature changes, the GDP growth rate of trading partners, and an international commodity price index have significant: (i) negative contemporaneous effects on action-based fiscal consolidations; (ii) positive contemporaneous effects on GDP growth. These results imply that it is highly unlikely that action-based fiscal consolidations are exogenous to contemporaneous GDP growth. Using an instrumental variables approach, I find that action-based fiscal consolidations have significant positive effects on GDP growth.

Keywords

Fiscal Consolidations, GDP Growth, Identification, Narrative Approach, Simultaneous Systems of Equations

JEL Classification

E0, O4

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Fiscal Consolidations

by

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1. Introduction

For estimation of causal effects that fiscal consolidations have on GDP growth a necessary condition is that the fiscal consolidations are exogenous. In particular, GDP growth should have no effect on the magnitude of fiscal consolidations. This is the contemporaneous exogeneity condition, see e.g. Stock and Watson (2018). The literature is well aware of the importance of this condition. Ramey (2016, 2019) provides an overview of that literature. One approach to identifying exogenous changes in fiscal policy, that has become increasingly popular, is the so-called narrative approach. According to the narrative approach the researcher reads policy documents -- such as budgets and central bank reports -- and then, based on what is written in those documents, classifies policy changes as exogenous if there is no indication in those documents that the policy change is in response to prospective economic conditions.

Does the absence of evidence -- based on what is written in the policy documents -- mean that the identified fiscal consolidations are exogenous to contemporaneous GDP growth?[1] This paper provides an answer to that question. My results are for the largest dataset, in terms of country coverage, that there exists: the IMF's dataset on action-based fiscal consolidations. This is a dataset where only those fiscal consolidations are recorded which, according to the narrative record, were primarily motivated by a desire to reduce the budget deficit. The first dataset on action-based fiscal consolidations was introduced in 2011 by Devries et al. (2011). The dataset covered 17 advanced economies during the period 1978 to 2009. The data have been extended to 14 countries in Latin America and the Caribbean during the period 1989 to 2016 by David and Leigh (2018). The IMF dataset covers both tax- and expenditure-based consolidations. Importantly, only those consolidations that were implemented as announced are included in the dataset. The IMF dataset on fiscal consolidations has been widely used in the literature to estimate effects of fiscal

1 Throughout this paper, I will use exogenous as a short-hand for contemporanous exogeneity. Ramey (2010) pointed to the possibility that policy makers do not randomly reduce a deficit. If fiscal consolidations were random then the condition of contemporaneous exogeneity would be satisfied. Contemporanous exogeneity is distinct from predictability; see e.g. Alesina et al. (2015).

consolidations on GDP growth, either as the main variable (e.g. Guajardo et al., 2014; Jorda and Taylor, 2016; Cloyne et al., 2020; Carriere-Swallow et al., 2021); as a robustness check (Pappa et al. 2015); or to construct fiscal plans (Alesina et al. 2015, 2018). In all of those papers, the identifying assumption was that contemporaneous GDP growth has no effect on the magnitude of fiscal consolidations.

Theoretically, there is at least one compelling reason why action-based fiscal consolidations are not exogenous to contemporaneous GDP growth: automatic stabilizers. On the tax side, slower GDP growth means that tax revenues decline. On the expenditure side, slower GDP growth means that government expenditures increase because more people are seeking unemployment and welfare payments. Both of these forces are well understood in public finance and macroeconomics. These forces are automatically at work due to the way the tax and spending system is designed. For a given reduction of the deficit that a policy maker desires to achieve: tax rates have to increase more the slower is GDP growth (to counteract the automatic decline in tax revenues when the growth rate of GDP decreases); discretionary government expenditures have to decrease more the slower is GDP growth (to counteract the automatic increase in government expenditures that arise from more people seeking unemployment and welfare payments when the GDP growth rate decreases). Due to automatic stabilizers, contemporaneous GDP growth has a negative effect on the magnitude of action-based fiscal consolidations.

On the empirical side, providing an answering to the question whether action-based fiscal consolidations are exogenous to contemporaneous GDP growth requires the use of an econometric model and country-specific variables that fulfill the following two conditions. First, the variables have to be exogenous to contemporaneous GDP growth and fiscal consolidations. The second condition is that they should have a significant effect on GDP growth. Three candidate variables that likely fulfill these two conditions are: (i) year-to-year changes in temperature; (ii) the GDP growth rate of trading partners; and (iii) an international commodity price index. Among these three variables, the one that is clearly exogenous to the annual GDP growth rate of a country is the year-to-year change in the country-specific mean temperature. The second variable is exogenous to the GDP growth of a country, if that country's GDP is only a tiny fraction of the trading partners' GDP. The third variable is exogenous to the GDP growth of a country if that country is a price-taker on the international commodity market, i.e. the country exports or imports only a small fraction of the globally traded commodity.

Controlling for country and time fixed effects, my panel model estimates show that all three of these candidate variables have individually a significant effect on GDP growth; and, they also have individually a significant effect on action-based fiscal consolidations. I am not the first one to document that these three variables have a significant effect on annual GDP growth. There are numerous papers that have used these variables in various contexts where one of the outcome variables is GDP growth.[2] I chose these three variables precisely because there exists a literature that has documented a significant effect of these variables on GDP growth.

The novel empirical result of this paper is that year-to-year changes in temperature, GDP growth of trading partners, and the international commodity price index have a significant contemporaneous effect on action-based fiscal consolidations. Importantly, the sign of the effects are the same across all three of these variables: that is, each of these variables has a significant positive contemporaneous effect on annual GDP growth; and each of these variables has a significant negative contemporaneous effect on action-based fiscal consolidations. Taken together, these results suggest that it is highly unlikely that action-based fiscal consolidations are exogenous.

The reduced-form results are important for several reasons. First, they imply that the identifying assumption of exogeneity is not satisfied in those papers that have used the IMF's action-based fiscal consolidations variable on the right-hand side in econometric models, estimated

2 For temperature, examples of papers that document a significant effect on GDP growth are Dell et al. (2012), Burke et al. (2015), and Gallic and Vermandel (2020). In IV estimations of the contemporaneous effects of annual GDP growth on tax rates, Vegh and Vulletin (2015) showed that GDP growth of trading partners and an international commodity price index are relevant instruments for GDP growth. There are many other papers that have documented a significant effect of these variables on GDP; examples are Kose (2002), Acemoglu et al. (2008), Brueckner et al. (2012), and Fernandez et al. (2017).

by least squares, where the dependent variable is annual GDP growth. This is obviously an important result as there is currently a lot of focus on fiscal policy and its effects on GDP growth. Second, the findings speak to the general question of whether a narrative approach (i.e. read policy documents to look for absence of evidence) is suitable for identifying policy changes that are exogenous to contemporaneous GDP growth.[3] The answer to that question is: no, the narrative approach is not suitable for identifying fiscal consolidations that are exogenous to contemporaneous GDP growth when the motive for the fiscal consolidation is budget deficit reduction.

To be clear: There is immense value in the narrative approach. By reading policy documents, one can identify announcements and the main motive for the fiscal consolidation. The issue with the narrative approach that I am pointing out is that it is wrong to assume that tax or government spending changes, which are made by policy makers in order to reduce a budget deficit, are exogenous to contemporaneous GDP growth. There are other motives for fiscal policy changes: for example, wars fought overseas -- see e.g. Ramey (2011) or Ramey and Zubairy (2018). My paper's results are specific to fiscal policy changes motivated by budget deficit reduction. No inference should be made from the results in my paper with regard to changes in fiscal policy, identified from the narrative record, that are due to motives other than budget deficit reduction.

The narrative approach is not the only approach that exists in the literature for identifying causal effects of fiscal consolidations: There are approaches in the fiscal policy literature that use national accounts data on government spending and tax revenues. For example, Blanchard and Perroti (2002) used the assumption that, at a quarterly frequency, government spending is exogenous. Blanchard and Perotti draw on an outside estimate of the output elasticity of tax revenues to construct the residual variation in tax revenues that is not due to GDP and use that as an instrument for tax revenues. Another approach to identifying causal effects is to use sign restrictions, see e.g. Mountford and Uhlig (2009).

3 The narrative approach was pioneered by Friedman and Schwartz (1963) and has since been applied to monetary policy, fiscal policy, and macroprudential policy. See Ramey (2016) for a discussion of recent papers that have applied a narrative approach to various types of economic policy.

Romer and Romer's (2010) main critique of these alternative approaches was that there are likely to be variables, which are omitted from the econometric model, that have a direct contemporaneous effect on both GDP growth and fiscal variables. Romer and Romer advocated for the narrative approach. Their assumption was that, if the narrative record indicates that a fiscal policy change was mainly motivated by a desire to reduce an inherited budget deficit then the fiscal policy change identified from the narrative record is exogenous. My reduced-form findings suggest that this assumption is, in general, untenable.

While important and interesting in their own right, my reduced-form findings, as such, are not constructive for the literature that seeks to estimate causal effects of fiscal consolidations on GDP growth. Fortunately, methods exist that enable to achieve identification if one is willing to impose two types of exclusion restrictions in a simultaneous system of two equations. The first set of exclusion restrictions is that the effects of temperature changes, GDP growth of trading partners, and the international commodity price index only affect fiscal consolidations through GDP growth. The second exclusion restriction is that the residual variation in fiscal consolidations that is not due to GDP growth is orthogonal to the error term in the GDP growth equation.

At least since the 1980s, see e.g. Hausman et al. (1987), it has been known that, if valid, two exclusion restrictions are sufficient to identify a simultaneous system of two equations. See also Ramey (2016, Section 2.3.2). This type of IV strategy to achieve identification is not new to the fiscal policy literature. Specifically, in the context of this paper the two equations are: (1) where GDP growth contemporaneously affects the magnitude of fiscal consolidations; (2) where the magnitude of fiscal consolidations affects GDP growth contemporaneously. Under the exclusion restriction of a zero covariance of the error terms in equations (1) and (2), I only need external instruments for one equation and then use the residual from that estimated equation as an instrument variable to identify the coefficient of interest in the other equation.

I achieve identification of the simultaneous system of two equations in two steps. In the first step, I identify equation (1) using temperature changes, GDP growth of trading partners, and the international commodity price index as excluded instruments for GDP growth. The instrumental variables estimates show that GDP growth has contemporaneously a significant negative effect on the magnitude of fiscal consolidations. On average, a one percentage point increase in annual GDP growth decreases the magnitude of an action-based fiscal consolidation by about 0.08 percent of GDP in the same year. This is a large effect: The effect is equivalent to about one-quarter of the average action-based fiscal consolidation in the sample. (In the sample the average action-based fiscal consolidation is around 0.3 percent of GDP.) I document that the estimated contemporaneous effect of GDP growth on fiscal consolidations is robust to using alternative instruments – that is, all three instruments jointly, or one instrument at a time; including additional control variables such as lags of GDP growth and lags of fiscal consolidations; and excluding from the sample the 5 largest economies.

In the second step, I use the residual variation in fiscal consolidations that is not due to GDP growth (i.e. the residual from the estimated equation (1)) as an instrument for fiscal consolidations in equation (2) where the dependent variable is GDP growth. The results are astounding. They completely overturn previous findings in the literature. Using a local-projections IV approach, my estimates show that the response of GDP growth to fiscal consolidation shocks is positive and significantly different from zero: over a horizon of one year, a fiscal consolidation equal to 1 percent of GDP increases GDP by about 1.8 percent; over a horizon of two years and three years the cumulative GDP gain relative to the size of the cumulative fiscal consolidation shock is equal to about 1.5 and 1.4, respectively.

Previous literature that used the IMF data on action-based fiscal consolidations as an explanatory variable in models, estimated by least squares, has consistently reported negative effects of fiscal consolidations on GDP growth. As shown in this paper, contemporaneous GDP growth has a significant negative effect on action-based fiscal consolidations. Hence, least squares regressions suffer from a negative reverse causality bias. Using the IMF's action-based fiscal consolidation variable in least squares regressions – even with standard controls – means that the results are biased towards finding negative effects of fiscal consolidations on GDP growth. The IV estimates that I report in this paper do not suffer from this negative reverse causality bias.

Why do action-based fiscal consolidations have a positive effect on GDP growth? At first hand, this result seems inconsistent with a very large number of both theoretical and empirical papers that has come up with positive fiscal multipliers. I believe that a compelling case can be made that the results in this paper are specific to action-based fiscal consolidations. Action-based fiscal consolidations are fundamentally different in nature to variations in government expenditures and tax revenues that arise due to other factors, such as, for example, automatic stabilizers. Action-based fiscal consolidations are subject to political economy issues. See Yared (2019) for an overview of the political economy literature on debt dynamics. In that literature, present-bias of policy makers is viewed as an important determinant of debt dynamics. The larger the present-bias, the larger are the distortions. If throughout time policy makers differ in their degree of present-bias, and their present-bias is private information, then a fiscal consolidation is a signal that the policy maker has a relatively low present-bias. Only those policy makers with a low present-bias will choose to reduce a budget deficit. Therefore, action-based fiscal consolidations are associated with reductions in distortions. Consistent with this explanation, I find that action-based fiscal consolidations have a significant positive effect on total factor productivity growth.

The remainder of the paper is organized as follows. Section 2 describes the data and estimation framework for answering the question whether action-based fiscal consolidations are exogenous. Section 3 discusses the results. In Section 4 I lay out a simultaneous system of two equations and show that, by imposing exclusion restrictions, one can still identify the effects that action-based fiscal consolidations have on GDP growth. In Section 5 I discuss IV estimates of the simultaneous system of equations. I provide a theoretical explanation for the empirical results in

Section 6. In Section 7 I conclude.

2. Data and Estimation Framework for: Are Action-Based Fiscal Consolidations Exogenous?

2.1 Data

2.1.1 Action-Based Fiscal Consolidations

The data on action-based fiscal consolidation are from the International Monetary Fund (Devries et al., 2011; David and Leigh, 2018). The data were assembled by IMF economists following the narrative approach. In the working paper that accompanies the dataset, Devries et al. (2011, pages 3 and 5 write) write:

> "We examine policymakers' intentions and actions as described in contemporaneous policy documents, and identify measures motivated primarily by deficit reduction....Following Romer and Romer (2010), we use the contemporaneous estimates contained in these sources since retrospective estimates are rarely available."

According to Repec[4], Devries et al. (2011) have been cited in over 118 distinct research papers. More than 10 citations per year, on average, over a time span of 10 years since release of the working paper. The number of citations suggests that many in the profession view the dataset as valuable. I, too, applaud the IMF economists for having put together such a comprehensive database. A database on discretionary fiscal policy aimed at consolidating the budget is extremely valuable. Such discretionary fiscal policies are different in nature to variations in the budget balance that arise due to automatic stabilizers. Discretionary fiscal policies aimed at consolidating the budget are actions taken by policy makers: tax-based consolidations are those actions by policy makers where tax rates are increased; expenditure-based consolidations are those actions taken by policy makers that reduce government expenditures (broadly defined, i.e. purchases of goods and services, social transfers and subsidies).

4 See https://ideas.repec.org/r/imf/imfwpa/2011-128.html and

The IMF's database on action-based fiscal consolidations is the largest that there exists. The data are publicly available and can be downloaded from the IMF's website. The dataset by Devries et al. (2011) covers 17 advanced economies during 1978-2009 and the dataset by David and Leigh (2018) covers 14 Latin American and Caribbean economies during 1989-2016. In each dataset there are three variables: the total value of the fiscal consolidation; tax-based fiscal consolidations; and expenditure-based fiscal consolidations. All three variables are expressed as a percent of a country's GDP. The data comprises only those fiscal consolidations that were implemented as announced. Fiscal consolidations that were announced and not implemented are not part of the dataset. The action-based fiscal consolidation data are annual.

2.1.2 Exogenous Variables

The data source for my baseline temperature variable is FAOSTAT (2021). As a robustness check, I will also report results for the temperature data of Dell et al. (2012). The baseline data on the trade-weighted GDP growth rate of trading partners and the international commodity price index are from Vegh and Vulletin (2015).[5] As a robustness check, I will report results for an international commodity price index that was constructed by the IMF economists Gruss and Kebhaj (2019). Specifically, I use the index that is based on time-invariant average GDP shares of commodity net-exports. I will also report results for the net-barter terms of trade. Data on the net barter terms of trade are from the World Development Indicators (World Bank, 2021).

2.1.3 Descriptive Statistics

Appendix Table 1 shows descriptive statistics for an unbalanced panel of 31 countries during 1978-2016. The table reports descriptive statistics for the largest sample for which data are available on action-based fiscal consolidations. The descriptive statistics for the other variables are computed for

5 For more details on how these variables are constructed and justification for why they are exogenous to GDP growth, see page 351 of Vegh and Vulettin (2015).

a sample with observations that is either equal to or slightly smaller than that for which data are available on action-based fiscal consolidations. For Ecuador, there are no data in the Vegh and Vulletin (2015) dataset on GDP growth of trading partners and the international commodity price index. For Belgium, data on GDP growth of trading partners are available from 1998 onward and the data from FAOSTAT on the temperature change are available from 2000 inwards.

2.2 Estimation Framework

To examine exogeneity of the IMF's action-based fiscal consolidation variable, I use a panel model:

(1) $$FiscalConsolidation_{it} = a_i + b_t + \alpha Z_{it} + u_{it}$$

where *FiscalConsolidation* is the IMF's action-based fiscal consolidation variable in year *t* and country *i*. (In the sections that follow, where I discuss estimates of the above equation, I will use fiscal consolidations as a short-hand for the IMF's action-based fiscal consolidation variable.) The model includes country and year fixed effects denoted by a_i and b_t, respectively. *Z* are variables that are exogenous to fiscal consolidations. Rejecting in equation (1) the null hypothesis that α=0 means that the IMF's action-based fiscal consolidations are unlikely to be exogenous.

The choice of variables for *Z* is motivated by the literature that has documented a significant effect of these variables on GDP growth. The three variables are: the year *t*-1 to *t* change in the mean annual temperature of country *i*; the year *t* growth rate of the GDP of trading partners of country *i*; and the year *t* international commodity price index for country *i*. In order to obtain an estimate of the average effect of these variables on GDP growth for the sample at hand, I estimate equation (2) for the same number of observations as equation (1):

(2) $$GDPGrowth_{it} = c_i + b_t + \beta * Z_{it} + e_{it}$$

Conditional on rejecting in equation (1) the null α=0, if in equation (2) one also rejects that $\beta=0$ then it is unlikely that -- in models where the dependent variable is GDP growth and the right-hand-side variable is fiscal consolidation -- fiscal consolidations fulfill the contemporaneous exogeneity condition. The argument is straightforward. First, it is implausibly to think that any of the variables in *Z* affect GDP growth because of their effect on fiscal consolidations. Second, it is plausible that these variables affect consolidations because of their effect on GDP growth: temperature changes affect GDP growth because of their effect on changes in agricultural productivity; GDP growth of trading partners affects GDP growth of a country because it affects the demand for that country's exports; the international commodity price index affects GDP growth of a country because it affects the country's terms of trade that in turn affects the country's value of net-exports.[6]

3. Empirical Results for: Are Action-Based Fiscal Consolidations Exogenous?

3.1 Contemporaneous Effects of Temperature Changes

Table 1 shows that the year *t*-1 to *t* change of annual mean temperatures has significant contemporaneous effects on both the magnitude of fiscal consolidations and on GDP growth. For the estimates shown in Table 1, the temperature data are from FAOSTAT (2021).

The first two columns of Table 1 show that temperature changes have a significant negative contemporaneous effect on the magnitude of fiscal consolidations. Specifically, in column (1) of Table 1 one can see that the estimated coefficient on temperature changes is around -0.07. The estimated coefficient has a standard error of around 0.04. One can reject the hypothesis that the coefficient is equal to zero at the 10 percent significance level (p-value 0.06). Column (2) reports estimates for the sub-sample that excludes the 5 largest economies. One can see that in this sub-sample the contemporaneous effect of temperature changes on fiscal consolidations is somewhat larger in absolute. That is, in column (2) the coefficient on temperature changes is around -0.10 and has a standard error of 0.04. One can reject the hypothesis that this coefficient is equal to zero at the

6 Vegh and Vulletin (2015) also used the US real interest rate as an instrument for GDP growth. I do not report results for the US real interest rate because my panel models include time fixed effects. The US real interest rate is perfectly collinear with the time fixed effects. I have estimated panel models without time fixed effects and included the US real interest rate on the right-hand side. I found a significant positive effect of the US real interest rate on the magnitude of action-based fiscal consolidations in the sample that excludes the US economy: a one percentage point increase in the US real interest rate in year *t* increases the magnitude of an action-based fiscal consolidation by about 0.03 percent of GDP.

5 percent level (p-value 0.02). Quantitatively, the estimates reported in columns (1) and (2) suggest that a one standard deviation increase in the year *t*-1 to *t* change in temperature decreases the magnitude of a fiscal consolidation in year *t* by around 0.04 to 0.06 percent of GDP.

Columns (3) and (4) of Table 1 show that temperature changes have a significant positive contemporaneous effect on GDP growth in the sample in which temperature changes have a significant negative contemporaneous effect on fiscal consolidations. The country-year observations in columns (3) and (4) are exactly the same as in columns (1) and (2), respectively. In column (3) of Table 1 one can see that the estimated coefficient on temperature changes is around 0.71. The estimated coefficient has a standard error of around 0.20. One can reject the hypothesis that the coefficient is equal to zero at the 1 percent significance level (p-value 0.00). Column (4) reports the estimated coefficient on temperatures for the sub-sample that excludes the 5 largest economies. One can see that in this sub-sample the contemporaneous effect of temperature changes on GDP growth is somewhat larger in absolute. That is, in column (4) the coefficient on temperature changes is 0.75 and has a standard error of 0.22. One can reject the hypothesis that this coefficient is equal to zero at the 1 percent level (p-value 0.00). Quantitatively, the estimates reported in columns (3) and (4) suggest that a one standard deviation increase in the year *t*-1 to *t* change in temperature increases GDP growth in year *t* by around 0.4 percentage points.

Appendix Table 2 shows that similar results are obtained for the temperature data used in Dell et al.'s (2012) study of the effects that temperature has on annual GDP growth. For comparison, Appendix Table 2 is structured exactly as Table 1. Note that there are fewer observations in Appendix Table 2 than in Table 1. The fewer observations in Appendix Table 2 is due to the Dell et al. (2012) data ending in 2006. The number of countries is the same in Appendix Table 2 and Table 1.

A short paragraph is warranted regarding the result in Table 1 and Appendix Table 2 that temperature changes have a positive effect on GDP growth. The result should be read as an average effect for the sample at hand. Average temperature of the countries in the sample is much lower -- about 7 degrees less -- than average temperature of countries in the rest of the world (i.e. those countries for which there are no data available on action-based fiscal consolidations). Burke et al. (2015) showed that temperature increases have a positive effect on productivity in relatively cold countries; while the opposite is the case in hot countries.

3.2 Contemporaneous Effects of GDP Growth of Trading Partners

Table 2 shows that the GDP growth rate of trading partners has significant contemporaneous effects on both the magnitude of fiscal consolidations and on GDP growth. The first two columns of Table 2 show that the GDP growth rate of trading partners has a significant negative contemporaneous effect on the magnitude of fiscal consolidations. Specifically, in column (1) of Table 2 one can see that the estimated coefficient on GDP growth of trading partners is around -0.25. The estimated coefficient has a standard error of around 0.08. One can reject the hypothesis that the coefficient is equal to zero at the 1 percent significance level (p-value 0.01). Column (2) shows that the estimated coefficient on GDP growth of trading partners is similar for the sub-sample that excludes the 5 largest economies. One can see in column (2) that the coefficient on GDP growth of trading partners is around -0.25 and has a standard error of 0.09. One can reject the hypothesis that this estimated coefficient is equal to zero at the 1 percent level (p-value 0.01). Quantitatively, the estimates reported in columns (1) and (2) suggest that a one standard deviation increase in GDP growth of trading partners in year t decreases the magnitude of a fiscal consolidation in year t by around 0.13 percent of GDP.

Columns (3) and (4) of Table 2 show that GDP growth of trading partners has a significant positive contemporaneous effect on GDP growth in the sample in which GDP growth of trading partners has a significant negative contemporaneous effect on fiscal consolidations. The country-year observations in columns (3) and (4) are exactly the same as in columns (1) and (2), respectively. In column (3) of Table 2 one can see that the estimated coefficient on GDP growth of trading partners is around 2.65. The estimated coefficient has a standard error of around 0.45. One can reject the hypothesis that the coefficient is equal to zero at the 1 percent significance level (p-value 0.00). Column (4) reports the estimated coefficient on GDP growth of trading partners for the sub-sample that excludes the 5 largest economies. The estimated coefficient is 2.61 and has a standard error of 0.46. One can reject the hypothesis that this coefficient is equal to zero at the 1 percent level (p-value 0.00). Quantitatively, the estimates reported in columns (3) and (4) suggest that a one standard deviation increase in the GDP growth of trading partners in year *t* increases GDP growth in year *t* by around 1.4 percentage points.

3.3. Contemporaneous Effects of an International Commodity Price Index

Table 3 shows that a country-specific international commodity price index has significant contemporaneous effects on both the magnitude of fiscal consolidations and on GDP growth. For the estimates shown in Table 3 the country-specific international commodity price index is from Vegh and Vuletin (2015).

The first two columns of Table 3 show that the commodity price index has a significant negative contemporaneous effect on the magnitude of fiscal consolidations. Specifically, in column (1) of Table 1 the estimated coefficient on the commodity price index is -0.017. The estimated coefficient has a standard error of 0.007. One can reject the hypothesis that this coefficient is equal to zero at the 5 percent significance level (p-value 0.03). Column (2) reports estimates for the sub-sample that excludes the 5 largest economies. In this sub-sample the contemporaneous effect of the commodity price index is slightly larger in absolute. That is, in column (2) the coefficient on the commodity price index is around -0.018 and has a standard error of 0.008. One can reject the hypothesis that this estimated coefficient is equal to zero at the 5 percent level (p-value 0.04). Quantitatively, the estimates reported in columns (1) and (2) suggest that a one standard deviation increase in commodity price index in year *t* decreases the magnitude of a fiscal consolidation in year *t* by around 0.10 percent of GDP.

Columns (3) and (4) of Table 3 show that the commodity price index has a significant positive contemporaneous effect on GDP growth in the sample in which the commodity price index has a significant negative contemporaneous effect on fiscal consolidations. The number of observations in columns (3) and (4) are exactly the same as in columns (1) and (2), respectively. In column (3) of Table 3 one can see that the estimated coefficient on the commodity price index is around 0.20. The estimated coefficient has a standard error of around 0.06. One can reject the hypothesis that the estimated coefficient is equal to zero at the 1 percent significance level (p-value 0.01). Column (4) reports the estimated coefficient for the sub-sample that excludes the 5 largest economies. In this sub-sample the coefficient on the commodity price index is 0.18 and has a standard error of 0.06. One can reject the hypothesis that this coefficient is equal to zero at the 1 percent level (p-value 0.01). Quantitatively, the estimates reported in columns (3) and (4) suggest that a one standard deviation increase in the commodity price index in year *t* increases GDP growth in year *t* by around 1 percentage point.

I document in Appendix Table 3 that results are similar when using a country-specific international commodity net-export price index from Gruss and Kebhaj (2019). For this index the international commodity prices are geometrically weighted with the country-specific, average (that is, time-invariant) net-export-GDP shares of the commodities. Appendix Table 3 is structured exactly as Table 3. One can see that both quantitatively and qualitatively the estimates in Appendix Table 3 are similar to those in Table 3. The number of observations is larger in Appendix 3 than in Table 3 because data on the commodity price index of Vegh and Vuletin (2015) are available up to 2013; data on the commodity price index of Gruss and Kebhaj (2019) are available up to 2018. (The IMF fiscal consolidations data are available up to 2016.)

Appendix Table 4 shows estimates using as a right-hand-side variable the World Bank's

(2021) index of the net-barter terms of trade.[7] Columns (1) and (2) of Appendix Table 4 show that the terms of trade have a significant negative contemporaneous effect on fiscal consolidations. A one standard deviation increase in the year *t* terms-of-trade index decreases the magnitude of a fiscal consolidation in year *t* by around 0.12 percent of GDP. Columns (3) and (4) show that the terms of trade have a significant positive contemporaneous effect on GDP growth. A one standard deviation increase in the year *t* terms-of-trade index increases year *t* GDP growth by around 1.8 percentage points.

The World Bank's (2021) index of the net barter terms of trade is available for all countries and years for which data on action-based fiscal consolidations are available. The net barter terms of trade index is calculated as the percentage ratio of the export unit value indexes to the import unit value indexes, measured relative to the base year 2000. For the purpose of having an exogenous right-hand side variable, one would like to use an index that has: (i) fixed export and import weights; (ii) time varying prices. While this is the case for the international commodity price indices it is not clear from the World Bank website whether the net-barter terms of trade index is constructed using fixed or time-varying export and import weights. This makes the net barter terms of trade index from the World Bank (2021) somewhat less attractive for use in this particular paper relative to an international commodity price index that is constructed using time-varying international commodity prices and fixed, country-specific net-export-GDP-shares of the commodities.

3.4 Robustness: Poisson Estimator

In this section I will discuss estimation results from a poisson fixed effects estimator. Fiscal consolidations do not occur every period: For about 70 percent of the observations in the sample the action-based fiscal consolidation variable is zero. For about 1 percent of the observations the fiscal consolidation variable takes on negative values, while in the remaining 29 percent of observations

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the fiscal consolidation variable takes on positive values. As noted in e.g. Carriere-Swallow et al. (2021): "Negative values reflect the expiration of temporary fiscal consolidation measures or the implementation of expansionary measures with long-run motivations other than budget deficit reduction." For the poisson estimates reported in this section, I set negative values of the action-based fiscal consolidation variable to zero. (In the OLS estimates reported in Section 3.1 to 3.3 I used the fiscal consolidation variable as is.)

Appendix Table 5 reports the relevant results. Columns (1) to (4) report estimates for the largest sample. Columns (5) to (8) show estimation results for the sub-sample that excludes the 5 largest economies. The right-hand-side variables are temperature changes, the GDP growth rate of trading partners, and the international commodity price index (coefficients reported are for the year *t* effect). One can see from Appendix Table 5 that the estimated coefficients on the right-hand-side variables are negative and significantly different from zero at the conventional significance levels. Thus, poisson model estimates yield the same result as OLS: temperature changes, the GDP growth rate of trading partners, and an international commodity price index have a significant negative, contemporaneous effect on the magnitude of fiscal consolidations.

4. Estimation Framework: Identification of a Simultaneous System of Two Equations

Consider the simplest possible simultaneous system of two equations:

(1) $FiscalConsolidation = \alpha GDPGrowth + u$

(2) $GDPGrowth = \beta * FiscalConsolidation + e$

where I have dropped subscripts to keep the notation as simple as possible. (In the spirit of the Frisch-Waugh-Lovell theorem, one can think of the above variables as the residuals obtained from separate regressions of GDP growth and fiscal consolidations on a set of control variables, such as country and time fixed effects, past GDP growth and past fiscal consolidations.)

Under the assumption that cov(u,e)=0, the least squares estimate of β in equation (2) is:

$(I) \quad \beta^{LS} = \beta + cov(FiscalConsolidation,u) = \beta + \alpha(1\text{-}\alpha\,\beta)^{-1}\sigma^2(e)/\sigma^2(F)$

where $\sigma^2(e)$ is the variance of the error term *e* and $\sigma^2(F)$ is the variance of fiscal consolidations. Hence, only if α is equal to zero does least squares estimation of equation (2) yield a consistent estimate of *β*.

In order to identify the simultaneous system of two equations I need at least one variable, denoted here by *Z,* that satisfies the following conditions: (i) *Z* is exogenous to GDP Growth and fiscal consolidations; (ii) *Z* affects GDP Growth; and (iii) *Z* affects fiscal consolidations through its effect on GDP Growth:

$(2') \quad GDPGrowth = \beta * FiscalConsolidation + \varphi Z + e'$

Under conditions (i)-(iii), *Z* can be used as an instrument for GDP growth to obtain a consistent estimate of α in equation (1).

Note that from equations (1) and (2'), it follows that the reduced-form effect of *Z* on fiscal consolidations is αφ. Conditional on GDP Growth, the effect of Z on fiscal consolidations is 0. That is, *Z* only affects fiscal consolidations through GDP growth. There is no direct effect of *Z* on fiscal consolidations.

Based on previous literature, I will use three variables as candidates for *Z*: temperature changes, the trade-weighted GDP growth rate of trading partners, and an international commodity price index. In the context of estimating effects of annual GDP growth on fiscal variables, there are a number of papers that have used these variables as instruments for GDP growth. (Though in none of those papers the outcome variable was the IMF's action-based fiscal consolidations variable.) Brueckner (2012) used an international commodity price index as an instrument for GDP growth to estimate the elasticity response of tax revenues to GDP growth for a panel of 33 Sub-Saharan African countries during the period 1980–2000. Brueckner et al. (2012) used an international oil price index as an instrument for GDP growth to estimate the contemporaneous elasticity response of government spending to GDP growth. Vegh and Vuletin (2015) used the GDP growth rate of trading partners and an international commodity price index as instruments for GDP growth when estimating the contemporaneous effect of GDP growth on tax rates; their panel consisted of 62 countries during the period 1960-2013. In all of the above papers, the assumption was that the commodity price index and GDP growth of trading partners only affect fiscal variables through their effect on GDP growth.

Once an estimate of α is obtained (from an IV regression where GDP growth is instrumented by Z) the next step is to construct the residual variation in fiscal consolidations that is not due to GDP growth, i.e. $u_{res} = FiscalConsolidation - \alpha^{hat,IV} GDPGrowth$. Then use u_{res} as an instrument for fiscal consolidations in equation (2). This yields the following IV estimator:

$$(II)\ \beta^{IV} = cov(u_{res}, GDPGrowth,)/cov(u_{res}, FiscalConsolidation)$$

$$= \beta + cov(u_{res}, e)/ cov(u_{res}, FiscalConsolidation)$$

$$= \beta + cov(u,e)/ cov(u, FiscalConsolidation)$$

$$= \beta$$

where line three uses that $\alpha^{hat,IV}=\alpha$, and hence $u_{res}=u$. The last line follows from the assumption that $cov(u,e)=0$. This is the same assumption that I made to derive the OLS estimator in equation (I).

Note that this IV strategy to identify a simultaneous system of two equations yields consistent estimates if one has at least one valid instrument, Z. One cannot identify the simultaneous system of equations by using least squares estimation of equation (1), compute the residual, and then use that residual as an instrument in equation (2). The reason why this will yield inconsistent estimates of β is that $\alpha^{hat,LS} \neq \alpha$, from which it follows that $u'_{res} = FiscalConsolidation - \alpha^{hat,LS} GDPGrowth \neq u$, and thus $cov(u'_{res}, e) \neq 0$.

5. Instrumental Variables Estimates of the Simultaneous System of Equations

5.1 The Contemporaneous Effect of GDP Growth on Fiscal Consolidations

5.1.1 Overidentified IV

Table 4 reports two-stage least squares estimates of the contemporaneous effect that GDP growth has on the magnitude of fiscal consolidations. The IV models in Table 4 are overidentified: there is one endogenous variable, GDP growth; and three instruments, namely, temperature changes, the GDP growth rate of trading partners, and the international commodity price index. The top panel of Table 4 reports the second-stage estimates (the effect that GDP growth in year *t* has on the magnitude of fiscal consolidations in year *t*); the bottom panel reports the first-stage estimates (of the effect that the instruments have on GDP growth).

The main message of the IV estimates reported in Table 4 is that contemporaneous GDP growth has a significant negative effect on the magnitude of fiscal consolidations. Column (1) of Table 4 reports estimates for the largest sample given the available data. In that column the estimated coefficient on year *t* GDP growth is -0.07 and has a standard error of 0.02. One can reject the hypothesis that the coefficient is equal to zero at the 1 percent significance level (p-value 0.003). The Anderson-Rubin test rejects that the coefficient on GDP growth in column (1) is equal to zero at the 5 percent level (p-value 0.031). Quantitatively, the estimated coefficient of -0.07 suggests that, on average, a one percentage point increase in annual GDP growth in year *t* decreases the magnitude of a fiscal consolidation by around 0.07 percent of GDP.

Standard test diagnostics suggest that the 2SLS estimates are based on instruments that are relevant and valid. The Kleibergen Paap F-stat and Cragg Donald F-stat for the hypothesis that the first-stage effects of the three instruments are jointly equal to zero is 17.0 and 19.7, respectively. The p-value of the Hansen J test that the three instruments are jointly uncorrelated with the second-stage error term is 0.99.

Column (2) of Table 4 reports two-stage least squares estimates for the sub-sample that excludes the 5 largest economies. Excluding the 5 largest economies leads to a slightly larger negative effect of GDP growth on fiscal consolidations. In column (2) the coefficient on GDP growth is -0.08 and has a standard error of 0.03. One can reject the hypothesis that the coefficient in column (2) is equal to zero at the 1 percent significance level (p-value 0.002). The Anderson-Rubin test rejects that the coefficient on GDP growth in column (2) is equal to zero at the 5 percent level (p-value 0.037).

Contemporaneous GDP growth has a significant negative effect on both tax- and expenditure-based fiscal consolidations. This can be seen from the estimates in columns (3)-(6) of Table 4. Contemporaneous GDP growth has a somewhat larger negative effect on tax-based consolidations than on expenditure-based consolidation. A one percentage point increase in year *t* GDP growth reduces the magnitude of a tax-based fiscal consolidation by around 0.05 percent of GDP. (That is, for the purpose of consolidating the budget, tax rates increase more the slower is GDP growth). For an expenditure-based consolidation this effect amounts to around 0.03 percent of GDP. (That is, for the purpose of consolidating the budget, discretionary government expenditures decrease more the slower is GDP growth.)

5.1.2 Just-Identified IV

IV estimation provides a local average treatment effect. The question arises then whether the finding in the previous section, that was obtained from an overidentified IV model, is due to the particular nature of any one of the three instruments. To provide an answer to that question, Table 5 reports estimates of just-identified IV models. In these models the dependent variable is the magnitude of fiscal consolidations in year *t*, and the endogenous right-hand-side variable is GDP growth in year *t*.

The estimated models in Table 5 are just identified: there is one instrument for one endogenous variable, GDP growth. Specifically, in columns (1) and (2) of Table 5 the instrument for GDP growth in year *t* is the GDP growth rate of trading partners in year *t*. In columns (3) and (4) the instrument for year *t* GDP growth is the year *t* international commodity price index. In columns (5) and (6) the instrument for year *t* GDP growth is the year *t*-1 to *t* change in temperature change.

Columns (1), (3), (5) show results for the largest sample, and columns (2), (4), and (6) show results for the sample that excludes the 5 largest economies. The top panel of Table 5 reports the estimated second-stage coefficient on GDP growth. The bottom panel reports the first stage effect that the instrument has on GDP growth.

From the top panel of Table 5 one can see that the second-stage estimates on GDP growth in the just-identified 2SLS regressions are similar -- both quantitatively and statistically -- across the three different instruments. In column (1), where the excluded instrument is the GDP growth rate of trading partners, the estimated IV coefficient on year *t* GDP growth is -0.09 and has standard error of 0.03. In column (3), where the excluded instrument is the international commodity price index, the estimated IV coefficient on year *t* GDP growth is -0.08 and has a standard error of 0.04. When the instrument is the temperature change, see column (5), the estimated IV coefficient on year *t* GDP growth is -0.10 and has a standard error of 0.05. Repeating the same regressions for the sub-sample that excludes the 5 largest economies yields estimated IV coefficients on GDP growth of -0.10, -0.10, and -0.14, respectively (see columns (2), (4), and (6)).

The similarity of estimated IV coefficients on GDP growth in the just-identified IV models shown in Table 5 suggests that the overidentified IV model estimates in Table 4 are not driven by a particular instrument. If it were the case that a negative effect of GDP growth on fiscal consolidations is due to the particular nature of any one of the three instruments, then one would see very different estimates on GDP growth in just-identified IV models depending on what particular instrument is used. As Table 5 shows that is not the case.

5.1.3 Tests for Direct Effects of the Instruments on Fiscal Consolidations

There are exclusion restrictions underlying the IV regressions: namely, that the instruments only affect fiscal consolidations through GDP growth. Tables 1 to 3 showed that there are significant negative reduced-form effects of each instrument on fiscal consolidations. The exclusion restriction of no direct effect means that conditional on GDP growth temperature changes, GDP growth of trading partners, and the international commodity price index have no effect on fiscal consolidations. Testing this requires at least one instrument for GDP growth that is: relevant (i.e. has a significant effect on GDP growth); exogenous to GDP growth and fiscal consolidations; and only affects fiscal consolidations through GDP growth. Tests of direct effects of the instruments can only be made conditional on the assumption that a sub-set of the instruments are relevant and valid.

Table 6 shows that GDP growth of trading partners, the international commodity price index, and temperature changes have no significant direct effects on fiscal consolidations. This is the case for the largest sample (columns (1)-(3)) and the sub-sample that excludes the 5 largest economies (columns (4)-(6)). Conditional on GDP growth, the estimated effects that GDP growth of trading partners, the international commodity price index, and temperature changes have on fiscal consolidations are quantitatively small and are not significantly different from zero at the conventional significance levels.

Consider the estimates shown in column (1) of Table 6. In that column one can see that: (i) the coefficient on year *t* GDP growth is -0.08 and has a standard error of 0.02; (ii) the coefficient on the year *t*-1 to *t* temperature change is 0.01 and has a standard error of 0.04. While one can reject the null that the coefficient on GDP growth is equal to zero at the 1 percent level (p-value 0.00), one cannot reject the null that the coefficient on temperature changes is equal to zero at the conventional significance levels (p-value 0.85). Note that in column (1) of Table 6 GDP growth is instrumented with the GDP growth rate of trading partners and the international commodity price index, both variables from Vegh and Vulletin (2015). For comparison purposes: recall that in the reduced form the coefficient on temperature changes is -0.07 and has a standard error of 0.04 (see column (1) of Table 1). In terms of the size of these coefficients: the estimated reduced form effect is about seven times larger than the direct effect. In terms of standard errors: these are about the same for the estimated reduced-form and the estimated direct effect. Not rejecting the null of zero direct effect of temperature changes on fiscal consolidations is thus due to a small estimated coefficient, and not due to a large standard error.

In column (2) of Table 6 one can see: (i) the coefficient on GDP growth is -0.09 and has a standard error of 0.05; (ii) the coefficient on GDP growth of trading partners is 0.04 and has a standard error of 0.17. While one can reject the null that the coefficient on GDP growth is equal to zero at the 10 percent level (p-value 0.07), one cannot reject the null that the coefficient on GDP growth of trading partners is equal to zero at the conventional significance levels (p-value 0.81). In column (2) of Table 6 the instruments for GDP growth are temperature changes and the international commodity price index. For comparison purposes: recall that in reduced form the coefficient on GDP growth of trading partners is -0.25 and has a standard error of 0.08 (see column (1) of Table 1). In terms of the size of the coefficients: in absolute value, the reduced form effect is about six times larger than the direct effect. In terms of standard errors: the standard error on the estimated direct effect is about twice as large as the reduced-form effect. Not rejecting the null of a zero direct effect of GDP growth of trading partners on fiscal consolidations is thus mostly due to a smaller estimated coefficient, and not so much to a larger standard error.

Column (3) of Table 6 shows that: (i) the coefficient on GDP growth is -0.07 and has a standard error of 0.03; (ii) the coefficient on the international commodity price index is -0.005 and has a standard error of 0.012. While one can reject the null that the coefficient on GDP growth is equal to zero at the 5 percent level (p-value 0.02), one cannot reject the null that the coefficient on the international commodity price index is zero at the conventional significance levels (p-value 0.69). In column (3) of Table 6 the instruments for GDP growth are temperature changes and the GDP growth rate of trading partners. For comparison, in the reduced form the estimated coefficient on GDP growth of trading partners is -0.017 and has a standard error of 0.007 (see column (1) of Table 3). In terms of the size of the estimated coefficients: in absolute value, the reduced form effect is about three times larger than the direct effect. In terms of standard errors: the standard error on the estimated direct effect is about twice as large as the reduced-form effect. Not rejecting the null of a zero direct effect of international commodity prices on fiscal consolidations is thus mostly due to a smaller estimated coefficient, and not so much to a larger standard error.

5.1.4. A Dynamic Simultaneous System of Equations

The dynamic version of the simultaneous system of two equations is:

(1) $$FiscalConsolidation_{it} = a_i + b_t + \alpha GDPGrowth_{it} + \Gamma_1 X_{it-1} + \Gamma_2 X_{it-2} + u_{it}$$

(2) $$GDPGrowth_{it} = c_i + d_t + \beta FiscalConsolidation_{it} + \Pi_1 X_{it-1} + \Pi_1 X_{it-2} + \Theta Z_{it} + e_{it}$$

where subscript *i* refers to country *i* and *t* refers to year *t*. In the above system, X_{it-1} and X_{it-2} are vectors that include GDP growth and fiscal consolidations in years *t*-1 and t-2, respectively. *Z* are the same instrumental variables for GDP growth as in Section 5.1.1.

The main purpose of writing out a dynamic version of the simultaneous system of two equations is to facilitate comparison to the literature that has estimated dynamic effects of fiscal consolidations on GDP growth. I will provide estimates using local projection IV methods. Local projection methods are widely used in the empirical macro literature. A recent paper by Plagborg-Møller and Wolf (2021) shows that local projections and VARs estimate the same impulse responses. Montiel et al. (forthcoming) show that lag-augmented local projections yield standard errors that are asymptotically valid.

In this section, I will only discuss estimates of the contemporaneous effect that GDP growth in year *t* has on fiscal consolidation in year *t*. I will from now on refer to these estimates as the contemporaneous effect of GDP growth on fiscal consolidations over a horizon of one year. In the next section I will discuss estimates over horizons that exceed one year, e.g. two years and three years.

The dynamics in the model above follow an autoregressive process of order 2. I have specified the dynamics of the model as such in order to facilitate comparison to previous literature, i.e. Guajardo et al. (2014) and Carriere-Swallow et al. (2021), where equation (2) is specified as an AR(2) model. To examine sensitivity of the results to lag selection, I will also report estimates from a more parsimonious AR(1) model.

Including X_{it-1} and X_{it-2} as controls means that the estimated coefficients β and α are the effects of "shocks". Throughout their paper, Guajardo et al. (2014) and Carriere-Swallow et al. (2021) use the term "fiscal consolidation shocks". The term fiscal consolidation shock simply means that the innovation in the fiscal consolidation variable in year *t* is not forecastable by past events. As such a fiscal consolidation shock is not necessarily exogenous to contemporaneous GDP growth, although that was the assumption made in previous literature that estimated effects of fiscal consolidations on GDP growth using the IMF's data on action-based fiscal consolidations. That is, literature which used the IMF's fiscal consolidation variable estimated equation (2) by OLS, assuming that, in equation (1), $\alpha=0$. If in the dynamic model specified above $\alpha\neq0$, then OLS of equation (2) yields an inconsistent estimate of β. In particular, if $\alpha<0$, then $\beta^{OLS}<\beta$.

Table 7 reports instrumental variables estimates of α. These estimates are obtained by two-stage least squares estimations of the dynamic panel models. Column (1) of Table 7 reports estimates for equation (1), exactly as specified in this section. The estimates reported in column (1) are for the largest sample given the available data. One can see that the estimated coefficient on year *t* GDP growth is -0.08 with a standard error of 0.03. One can reject the null that the coefficient is equal to zero at the 1 percent significance level (p-value 0.004).

The IV estimate on year *t* GDP growth that is obtained from the dynamic model is similar to the static model. See Table 4 for comparison. There are fewer observations in Table 7 than in Table 4 because including lags of fiscal consolidations means that the first and second initial observations are lost. Re-estimating the static model on the same number of observations as in column (1) of Table 7 yields a coefficient on year *t* GDP growth of -0.07 and a standard error of 0.02.

Concerning the estimated coefficients on the control variables: Column (1) of Table 7 shows that the coefficient on year *t*-1 fiscal consolidations is positive and significantly different from zero. The coefficient on year *t*-2 fiscal consolidations is quantitatively small and not significantly different from zero at the conventional significance levels. The coefficient on year *t*-1 GDP growth is positive and not significantly different from zero while the coefficient on year *t*-2 GDP growth is negative and significantly different from zero at the 5 percent level.

Column (2) of Table 7 shows estimates of the dynamic model, but without including as controls GDP growth in years *t*-1 and *t*-2. Comparing column (2) to column (1) one can see that including lags of GDP growth has negligible effects on the estimated effect of year *t* GDP growth on fiscal consolidations. In column (2) the coefficient on year *t* GDP growth is -0.07 and has a standard error of 0.02.

Column (3) of Table 7 reports estimates of a more parsimonious model that only includes as a control variable the first lag of fiscal consolidations. The dynamic model in column (3) is an AR(1) model. The motivation for reporting in column (3) estimates of a more parsimonious model is that from columns (1) and (2) one can see that only the coefficient on *t*-1 fiscal consolidations is significantly different from zero; the coefficient on *t*-2 fiscal consolidations is not significantly different from zero. In column (3) the coefficient on *t*-1 fiscal consolidations is 0.40 and has a standard error of 0.05. Column (3) also shows that the estimated coefficient on GDP growth in year *t* is negative and significantly different from zero at the conventional significance levels. In column (3) the coefficient on GDP growth in year *t* is -0.07 and has a standard error of 0.02.

Comparing columns (1)-(3) one can see that the coefficient on GDP growth in year *t* is quantitatively similar in size across the different model specifications. This is also the case when re-estimating these models for the sub-sample that excludes the 5 largest economies, see columns (4)-(6).

The instrumental variables estimates in Table 7 are of high quality. Each instrument has individually a significant effect on GDP growth in year *t*. The Kleibergen Paap F-statistic is above

10 in all specifications. And according to the Hansen J-test one cannot reject at the conventional significance levels the null that the instruments are uncorrelated with the second stage error term.

One issue that arises in dynamic panel models with country fixed effects is the incidental parameter problem, see e.g. Wooldridge (2010). The standard way to address this problem is by using a system-GMM or difference-GMM estimator. I report estimation results from these estimators in Appendix Tables 6 and 7. To facilitate comparison between sys-GMM, diff-GMM and 2SLS estimates, Appendix Tables 6 and 7 are organized exactly as Table 7.

In Appendix Tables 6 and 7, the GMM-style instruments for lagged fiscal consolidations are third and higher order lags. GDP growth in year *t* is treated as an endogenous variable: I include in the instrument set temperature changes, GDP growth of trading partners, and the international commodity price index. GDP growth in years *t*-1 and *t*-2 is specified as a pre-determined variable.

Comparing 2SLS to sys-GMM and diff-GMM estimates, one can see that the coefficients on year *t* GDP growth are similar for the three estimators. In Appendix Table 6, the sys-GMM estimates on year *t* GDP growth range from -0.06 to -0.08. Appendix Table 7 shows that for the diff-GMM estimator, the estimated coefficients on year *t* GDP growth range from -0.07 to -0.08. For the 2SLS estimator, the estimated coefficients on GDP growth in year *t* range from -0.07 to -0.09. All of the coefficients on year *t* GDP growth are significantly different from zero at the conventional levels.

There is a visible difference across the three estimators with regard to the estimated coefficients on the lagged dependent variable. Sys-GMM and diff-GMM estimations yield larger coefficients on year *t*-1 fiscal consolidations than 2SLS estimations. For the coefficient on year *t*-2 fiscal consolidations, the sys-GMM and diff-GMM estimations yield coefficients that are smaller (i.e. more negative) than 2SLS regressions.

5.1.5 Integral Multipliers

The fiscal policy literature has computed so-called "integral multipliers", see e.g. Ramey (2016). The dynamic simultaneous equations model for integral multipliers is:

(1) $$FiscalConsolidation(h)_{it} = a_i + b_t + \alpha^h GDPGrowth(h)_{it} + \Gamma_1 X_{it-1} + \Gamma_2 X_{it-2} + u_{it}$$

(2) $$GDPGrowth(h)_{it} = c_i + d_t + \beta^h FiscalConsolidation(h)_{it} + \Pi_1 X_{it-1} + \Pi_1 X_{it-2} + \Theta Z(h)_{it} + e_{it}$$

where $GDPgrowth(h)_{it}$ is defined as the change in the log of GDP between years $t+h$ and t-1, i.e. $\log GDP_{it+h} - \log GDP_{it-1}$; and $FiscalConsolidation(h)_{it}$ is the sum of fiscal consolidations between years $t+h$ and t. X_{it-1} and X_{it-2} are vectors that include GDP growth and fiscal consolidations in years t-1 and t-2, respectively. $Z(h)_{it}$ is a vector that includes the sum of each instrument between years t+h and t-1. The coefficient α^h is the cumulative effect of GDP growth over *h* years on the sum of fiscal consolidations over *h* years. The cumulative effect of the sum of fiscal consolidations over *h* years on GDP growth over *h* years is β^h.

For each horizon *h*, I identify equation (1) by using *Z(h)* as instruments for *GDPgrowth(h).* The instruments are temperature changes, GDP growth of trading partners, and the international commodity price index, computed at the relevant horizon. In the IV regressions of the effect that *GDPgrowth(h)* has on *FiscalConsolidation(h),* I compute *Z(h)* for horizon *h* as the sum of each instrument between *t* and *t+h*. I will report IV estimates for *h*=0, 1, 2 (note that the time unit is years). This is the same number of horizons as in Carriere-Swallow et al. (2021).

Table 8 shows that α^h is negative for all horizons *h*=0, 1, 2. Column (1) of Table 8 shows the effect of GDP growth on fiscal consolidations for *h*=0; note that this is just a replication of column (1) of Table 7. Column (2) shows the effect of GDP growth on fiscal consolidations for *h*=1 and column (3) shows the effect for *h*=2. One can reject the null that the coefficient on *GDPgrowth(h)* is equal to zero at the 1 percent significance level for all *h*=0, 1, 2.

Quantitatively, the effects of GDP growth over horizon *h* on the sum of fiscal consolidations over horizon *h* are similar in size for all *h*=0, 1, 2. In columns (1)-(3) of Table 8, the coefficients on *GDPgrowth(h)* are -0.08, -0.07, and -0.07 for *h*=0, 1, 2, respectively. The interpretation of these estimated coefficients is as follows:

i. for *h*=0, a one standard deviation (equivalent to 4.2) increase in contemporaneous GDP growth over a horizon of one year reduces the magnitude of a fiscal consolidation over a horizon of one year by about 0.3 percent of GDP, this is equivalent to about 0.5 standard deviations.
ii. for *h*=1, a one standard deviation (equivalent to 7.2) increase in contemporaneous GDP growth over a horizon of two years reduces the magnitude of a fiscal consolidation over a horizon of two years by 0.5 percent of GDP, this is equivalent to about 0.4 standard deviations.
iii. for *h*=2, a one standard deviation (equivalent to 9.5) increase in contemporaneous GDP growth over a horizon of three years reduces the magnitude of a fiscal consolidation over a horizon of three years by 0.7 percent of GDP, this is equivalent to about 0.5 standard deviations.

Results are similar for the sub-sample that excludes the 5 largest economies. See columns (4)-(6) of Table 8. For the sub-sample that excludes the 5 largest economies, the estimated coefficients on *GDPgrowth(h)* are -0.09, -0.06, and -0.06 for *h*=0, 1, 2, respectively. For each of these estimated coefficients one can reject the null that the coefficient is equal to zero at the 1 percent significance level.

The instrumental variables estimates in Table 8 are of high quality. Each instrument has individually a significant effect on *GDP growth(h)* for all *h*=0, 1, 2. The Kleibergen Paap F-statistic is above 10 in all specifications. According to the Hansen J-test, one cannot reject at the conventional significance levels the null that the instruments are uncorrelated with the second stage error term.

5.2 The Response of GDP Growth to Fiscal Consolidations

The literature, see in particular Guajardo et al. (2014) and Carriere-Swallow et al. (2021), reported estimates of β^h from OLS estimations of equation (2). The identifying assumption that previous literature made is that α^h=0 for all *h*. A necessary condition for OLS to yield consistent estimates of β^h is that in the simultaneous system of equations α^h=0. The instrumental variables estimates in Table 8 showed that α^h is negative for all horizons *h=0, 1, 2.* Hence, OLS estimation of equation (2) yields responses of GDP growth (cumulated over horizon *h*) to fiscal consolidation shocks (cumulated over horizon *h*) that are downward biased for all *h*.[8]

To correct for the downward bias, one needs an instrument when estimating equation (2). In this section, I will report instrumental variables of equation (2) where the instrument for fiscal consolidations is the residual variation in fiscal consolidation that is not due to GDP growth; i.e. u^{res} $=Fiscalconsolidation(h)-\alpha^{h,IV}\ GDPGrowth(h)$, where $\alpha^{h,IV}$ is the IV estimate of the coefficient on *GDPGrowth(h)* from Table 8. As shown in Section 4, this IV strategy is immune to the downward bias that arises in OLS estimation of equation (2) due to α^h<0.

Panel A of Table 9 shows IV estimates of the response of GDP growth to fiscal consolidation shocks. With regard to horizons and sample size, Table 9 is organized exactly as Table 8. That is, column (1) of Table 9 shows the estimated response of GDP growth to contemporaneous fiscal consolidation shocks at horizon *h*=0. Columns (2) and (3) show the estimates for *h*=1 and *h*=2, respectively. Columns (4)-(6) report results for the sub-sample that excludes the 5 largest economies.

According to the IV estimates, fiscal consolidation shocks have a positive effect on GDP growth. Column (1) of Panel A shows that the IV coefficient on *FiscalConsolidation(h=0)* is 1.84 and has a standard error 0.51. One can reject the null that this estimated coefficient is equal to zero at the 1 percent significance level (p-value 0.000). Columns (2) and (3) show that the IV estimates

8 With regard to equation (2, Carriere-Swallow included, in addition to the first and second lags of GDP growth and fiscal consolidations, current and lagged values of a commodity price index. Carriere-Swallow et al. did not include temperature changes or GDP growth of trading partners in equation (2). Note that even with a commodity price index as a control variable in equation (2), OLS of equation (2) still yields a downard biased estimate of β^h if in equation (1) α^h <0.

for horizon h=1 and h=2 are 1.46 and 1.38, respectively. One can reject the null that these effects are equal to zero at the 1 and 5 percent level respectively (the p-values are 0.007 and 0.023, respectively). The quantitative interpretation is as follows: over a horizon of one year (h=0), a fiscal consolidation equal to 1 percent of GDP increases GDP by about 1.8 percent; over a horizon of two years (h=1) and three years (h=2) the cumulative GDP gain relative to the size of the cumulative fiscal consolidation is equal to about 1.5 and 1.4, respectively.

Effects are similar for the sub-sample that excludes the 5 largest economies. See columns (4)-(6) of Table 9. For the sub-sample that excludes the 5 largest economies, the estimated coefficients on *FiscalConsolidation(h)* are 2.00, 1.61, and 1.52, respectively for h=0, 1, 2. For each of these estimated coefficients one can reject the null that the effect is equal to zero at the conventional significance levels (the p-values are 0.001, 0.010, and 0.030, respectively).

Confidence intervals for β^h based on asymptotic 2SLS standard errors are similar to bootstrapped intervals. For each IV regression in Panel A of Table 9, I computed 95 percent confidence intervals from a wild restricted efficient bootstrap over the t-statistic, with 1000 replications, clustered at the country level. I computed the bootstrapped confidence intervals using STATA's *boottest* command (Roodman et al., 2019). Appendix Figure 1 shows the confidence plots. The bootstrapped 95 percent confidence intervals for β^h are reported in Panel A of Table 9 just below the point estimates of β^h. For example, for column (1) of Panel A the bootstrapped 95% confidence interval is [0.72, 2.83]; the corresponding asymptotic 95% confidence interval can be computed from the point estimate and standard error shown in column (1) of Panel A: it is [0.83, 2.85].

Panel B of 9 reports OLS estimates. For all horizons h=0, 1, 2 the OLS estimates of β^h are negative. This means that OLS regressions suggest that fiscal consolidations reduce GDP growth. Specifically, according to the OLS estimates in columns (1)-(3) of Table 9 a fiscal consolidation equal to 1 percent of GDP decreases GDP by about 0.44 percent over a horizon of 1 year (h=0);

over a horizon of two years (h=1) and three years (h=2) GDP decreases by about 0.57 percent and 0.74 percent, respectively. This is the same result as in previous literature that used OLS to estimate equation (2). However, as argued above, OLS estimates of the response of GDP growth to action-based fiscal consolidations are downward biased.

Figure 1 plots the OLS and 2SLS estimates of β^h and their 95 confidence bands. The figure visualizes the results of columns (1)-(3) of Table 9. Recall that the coefficient β^h is the integral multiplier at horizon h, i.e. the ratio of the cumulative change in GDP over the cumulative change in fiscal consolidations. From Figure 1, one can see that the 2SLS estimates of the integral multipliers are positive while the OLS estimates are negative. OLS and 2SLS estimates of β^h are significantly different. For all $h=0, 1, 2$, the 95 percent confidence bands around the OLS and 2SLS estimates of β^h are non-overlapping. The Hausman test rejects the null that OLS and 2SLS estimates of β^h are the same, for each $h=0, 1, 2$, at the 1 percent level.

6. Theoretical Explanations for the Empirical Results

6.1 The Negative Effect of Contemporaneous GDP Growth on Action-Based Fiscal Consolidations

In this section, I provide a theoretical explanation for why contemporaneous GDP growth has a negative effect on the magnitude of action-based fiscal consolidations. The mechanism are automatic stabilizers: due to institutional design contemporaneous GDP growth has automatically a positive effect on the government's budget balance. Consequently, for any given increase in the budget balance that a policy maker desires to achieve: an increase in the contemporaneous GDP growth rate requires a smaller increase in tax rates (tax-based consolidation); a smaller decrease in government expenditures (expenditure-based consolidation). In the paragraphs below I formalize this explanation.

First, note that the budget, B, is the difference between tax revenues (R) and expenditures (E), i.e. $B=R - E$. For a given tax rate, τ, and discretionary government expenditures, g, automatic stabilizers imply that an increase in GDP growth has a positive effect on the budget. Totally differentiating the budget with respect to GDP growth, y, yields $dB=(R_y - E_y)dy > 0$, where $R_y \equiv \partial R/\partial y > 0$ and $E_y \equiv \partial E/\partial y < 0$.

The signs of the two derivatives above are supported by the empirical findings of a number of papers. An early empirical contribution was Fatas and Mihov (2001). Brueckner (2012) and Brueckner et al. (2012) provided empirical evidence from instrumental variables regressions of the response of tax revenues and government expenditures to GDP growth. Galeano et al. (2021) provide a detailed analysis of the components of automatic government spending. The empirical findings in these papers are, however, for samples of countries that are not exactly the same as in this paper's analysis. That leads to the question about external validity. Is there empirical evidence for automatic stabilizers in the sample of countries underlying this paper's empirical analysis?

Appendix Table 8 documents that contemporaneous GDP growth has a significant positive effect on the GDP share of tax revenues and a significant negative effect on the GDP share of government expenditures in the sample for which there are observations on action-based fiscal consolidations. The IV estimates in Appendix Table 8 show that a 1 percentage point increase in year t GDP growth increases the GDP share of tax revenues by more than 0.2 percentage points; a 1 percentage point increase in year t GDP growth decreases the GDP share of government expenditures by nearly 0.3 percentage points. The empirical evidence in Appendix Table 8 thus suggests that $R_y \equiv \partial R/\partial y > 0$ and $E_y \equiv \partial E/\partial y < 0$.

The definition of an action-based fiscal consolidation is that tax rates increase (tax-based consolidation), or that discretionary government expenditures decrease (expenditure-based consolidation). For a tax-based consolidation, totally differentiating the budget with respect to y and τ yields $dB=(R_y - E_y)dy + R_\tau d\tau$, where $R_\tau \equiv \partial R/\partial \tau$. It follows that $d\tau/dy = (R_y - E_y)/-R_\tau$. If the economy is to the left-side of the peak of the Luffer curve then $R_\tau > 0$. I assume that this is the relevant case since the policy maker's aim is to consolidate the budget, i.e. raise tax revenues by increasing the tax rate. Hence, $d\tau/dy = (R_y - E_y)/\text{-}R_\tau < 0$. This mathematical expression means that the faster is GDP growth (*dy>0*) the smaller the increase in the tax rate has to be for consolidating the budget. The result is symmetric: in order to consolidate the budget, the policy maker has to increase the tax rate more the slower is GDP growth (*dy<0*).

Now consider an expenditure-based consolidation. Totally differentiating the budget with respect to *y* and *g* yields $dB=(R_y - E_y)dy - E_g dg$, where $E_g \equiv \partial E/\partial g>0$. It follows that $dg/dy=(R_y - E_y)/E_g >0$. The faster is GDP growth (*dy>0*), the less the policy maker has to reduce discretionary expenditures in order to consolidate the budget. The result is symmetric: the slower is GDP growth (*dy<0*), the more discretionary expenditures have to be reduced by the policy maker in order to consolidate the budget.

Note that automatic stabilizers are active at any time frequency. The action-based fiscal consolidations data are annual, and so the time frequency for this paper's empirical analysis is annual. What about quarterly data? The narrative approach has been applied to several countries, in particular the US, where the time frequency was quarterly (see Ramey, 2016, 2019 for a discussion of these papers). Because automatic stabilizers are active at any time frequency, quarterly tax and expenditure shocks – identified from the narrative record, with the selection criteria that these policy changes were made by policy makers with a primary objective to reduce a budget deficit – are also endogenous to contemporaneous GDP growth.

Omitted Variables

There are variables other than GDP growth that have a direct contemporaneous effect on the budget. The issue for the empirical analysis that arises from this observation is omitted variables bias. I discuss this issue here, and not earlier on in the paper, because the theoretical framework above is useful for pinning down the sign of the omitted variables bias.

My IV estimates of the effect that action-based fiscal consolidations have on GDP growth are subject to omitted variables bias if there is a variable, omitted from the model, that: (i) has an effect on the budget beyond its effect on GDP growth; and (ii) the variable has an effect on GDP growth beyond its effect on the budget. Both of these conditions, (i) and (ii), have to be satisfied for there to be an omitted variables bias. (Variables that only affect the budget through their effect on GDP growth do not lead to omitted variables bias. And, there is also no omitted variables bias from variables that affect the budget directly but these variables have no effect on real GDP growth.)

I will argue below that it is very likely that the sign of the omitted variables bias is negative. That is, due to omitted variables bias, my IV estimates are a lower bound of the true positive effect that action-based fiscal consolidations have on GDP growth. Here is why.

Four omitted variables from the econometric model are: the unemployment rate, the interest rate set by the central bank, the level of public debt, and the old-age dependency ratio. All four of these variables are very likely to have a direct negative contemporaneous effect on the budget. An increase in the unemployment rate implies that more people seek unemployment benefits, and pay less income tax. With regard to the interest rate set by the central bank: an increase in the interest rate set by the central bank increases the deficit because interest payments on government debt increase. Similarly, the higher the level of public debt, the larger the debt service costs and hence the larger the deficit. An increase in the share of the population that is retired means that income tax revenues decline, and government expenditures automatically increase due to an automatic increase in pension payments.

When faced with larger unemployment rates, a higher nominal interest rate, larger public debt, and an increase in the old-age dependency ratio: a policy maker who wants to reduce a budget deficit has to increase tax rates more, and cut back more on discretionary expenditures. This implies that unemployment, the interest rate, debt, and the old-age dependency ratio – all four of these variables have a positive effect on the magnitude of action-based fiscal consolidations. It is also very likely that unemployment, the interest rate, debt, and the old-age dependency ratio have a direct negative contemporaneous effect on GDP growth.

Thus, with regard to my IV estimates of the effects that action-based fiscal consolidations have on GDP growth: these estimates are very likely to be downward-biased due to omitted variables. In the framework of Section 4, this means that $cov(u,e)<0$. To see this formally, extend both equations in Section 4 by a variable X: (1) $FiscalConsolidation = \alpha GDPGrowth + rX + u'$; (2) $GDPGrowth = \beta * FiscalConsolidation + fX + e'$. That is: $u=rX+u'$ and $e=fX + e'$. It follows that $cov(u,e)=rfVar(X)$. (If X is a vector then also the covariances between the *Xs* matter. For the four variables discussed above, the correlations are either positive or very close to zero.) For unemployment, the interest rate, debt, and the old-age dependency ratio: it is plausible to assume that $r>0$, and $f<0$. Hence, $cov(u,e)<0$. From this expression, it immediately follows that OLS estimates of the effects of action-based fiscal consolidations on GDP growth are also subject to an omitted variables bias. The sign of the omitted variables bias is the same for the IV estimator and the OLS estimator.

I have pinned down the sign of the omitted variables bias by using basic economic reasoning. I believe this is a fruitful strategy. At the country level, there is no random variation in fiscal policy variables. Because at the country-level there is no randomization of fiscal policy variables, omitted variables bias is always an issue. By acknowledging omitted variables bias and using basic economic reasoning, I have established that my estimates are likely to be a lower bound of the true positive effect that action-based fiscal consolidations have on GDP growth.

I note that one cannot just include unemployment, the interest rate, debt, and the old-age dependency ratio in year *t* as right-hand-side controls in the model. These variables are not exogenous. Including these variables in year *t* on the right-hand side without instrumenting would be the typical case of bad controls, see e.g. Angrist and Pischke (2009, p. 64). One can include lags of these variables, though that does not entirely resolve the issue of omitted variables bias. To go part way in empirically addressing this issue, I have estimated models that included lags of the following variables: the central government debt-to-GDP ratio, a government fractionalization index, the share of the population aged 65 and above, the unemployment rate, and the real internal rate of return. These variables were included on the right-hand-side in *t*-1 and *t*-2. The models also included as controls *t*-1 and *t*-2 GDP growth and *t*-1 and *t*-2 fiscal consolidations. I found that these models delivered significant positive effects of fiscal consolidations on GDP growth; quantitatively, the effects were slightly larger than the effects reported in Table 9. For example, the model that included the full set of control variables mentioned above showed that a fiscal consolidation equal to 1 percent of GDP increases GDP in the same year by around 2.4 percent.

6.2 The Positive Effect of Action-Based Fiscal Consolidations on GDP Growth

An explanation for why action-based fiscal consolidations have a positive effect on GDP growth is that a policy maker chooses to reduce a budget deficit when this is good for the economy. A robust result in the political science literature is that GDP growth affects election outcomes (see e.g. the review article by Lewis-Beck and Stegmaier, 2000). When the economy is going well incumbent governments are more likely to be re-elected.

One may think that the above immediately implies that a fiscal consolidation is only chosen by policy makers if the reduction in the deficit increases GDP growth. The argument that I want to make is more subtle though. For example, in Halac and Yared, 2014, policy makers observe private signals with regard to the state of the economy; and policy makers have a present-bias. Yared (2019) provides a discussion of the literature on optimal government debt and political economy forces that affect debt dynamics.

When a policy maker's type with regard to the extent of present-bias is exogenous (i.e. an innate characteristic of the particular policy maker) and private information, a fiscal consolidation acts as a signal: a policy maker who chooses to consolidate the budget is likely to have a smaller present-bias. The larger the present-bias of the policy maker, the more distortionary is fiscal policy.

To be clear: I am referring here to distortions in the economy that are due to an intertemporally sub-optimally high level of public debt. Why is the level of public debt sub-optimally high? The answer is present-bias of policy makers. See Yared (2019).

What I sketched above is a model where policy makers differ in their type with regard to the degree of present-bias. In that model, type is exogenously determined by nature. A policy maker with a relatively low present-bias is more likely to consolidate the budget, i.e. reduce the level of debt inherited from a series of deficits in the past. These deficits in the past occurred because policy makers in the past had a larger present-bias than the current policy maker who chooses to consolidate the budget. The current policy maker chooses to consolidate the budget because his type is closer to that of a benevolent planer. The smaller the present-bias of the policy maker, the larger the magnitude of the fiscal consolidation.

According to the argument above, action-based fiscal consolidations have a positive effect on GDP growth because they are associated with a reduction in distortions. If this is so then one should see that action-based fiscal consolidations have a positive effect on aggregate productivity. Appendix Table 9 shows that indeed action-based fiscal consolidations have a significant positive effect on total factor productivity. Furthermore, the table shows that there is a significant positive effect on investment and the trade balance. The estimated effect on private consumption is positive but not significantly different from zero at the conventional significance levels. Specifically, the estimates in Appendix Table 9 show that a fiscal consolidation in year t equal to 1 percent of GDP: increases total factor productivity growth in year t by around 0.6 percentage points; increases investment growth in year t by around 2.2 percentage points; and increases the GDP share of net-exports by around 0.8 percentage points. These effects are significantly different from zero at the 5 percent level or higher.

To further shed light on the macroeconomics effects, in particular, with regard to the role of price stickiness, I report effects that fiscal consolidations have on inflation and the real exchange rate. If prices are very sticky, then one should see an insignificant effect of fiscal consolidations on inflation. If on the other hand prices are flexible, then one should see a decrease in inflation.

Appendix Table 10 shows that fiscal consolidations have a significant negative effect on inflation. The real exchange rate depreciates significantly. Specifically, from Appendix Table 10 one can see that a fiscal consolidation in year t equal to 1 percent of GDP: decreases the growth rate of the GDP-deflator in year t by around 2.3 percentage points; decreases the year t growth rate of the real exchange rate by around 1.0 percentage points. These effects are significantly different from zero at the 5 percent level or higher.

Both tax- and expenditure-based consolidations have a positive effect on GDP growth. This can be seen from the instrumental variables estimates shown in Appendix Table 11. The positive effects on GDP growth are larger for expenditure-based consolidations than for tax-based consolidations. This is particularly the case countries for countries in Latin America and the Caribbean: in the LAC region, an expenditure-based consolidation equal to 1 percent of GDP increases GDP in the same year by about 8 percent; for a tax-based consolidation the effect is about 4 percent. In advanced economies, the effects of tax- and expenditure-based consolidations on GDP growth are also positive and significantly different from zero. However, quantitatively the effects of tax- and expenditure-based consolidations are smaller, on average, in the group of advanced economies than in the group of countries that are part of the Latin America and Carribean region. In advanced economies, an expenditure-based consolidation equal to 1 percent of GDP increases GDP in the same year by about 1.2 percent on average; for a tax-based consolidation the effect is equal to about 0.9 percent. For the sample of advanced economies that excludes France, Germany, Japan, United Kingdom, and United States (i.e. the 5 largest economies in the AE group) these effects amount to about 1.1 percent and 0.8 percent, respectively.

7. Conclusion

Action-based fiscal consolidations are fundamentally different in nature to variations in the budget balance that arise due to automatic stabilizers. Variations in the budget balance that are due to automatic stabilizers are, by definition, unrelated to the contemporaneous actions of policy makers. The institutional design of the tax and welfare system is such that, due to automatic stabilizers, tax revenues automatically increase and government expenditures automatically decrease when GDP growth increases. In contrast, action-based fiscal consolidations were actions taken by policy makers with the primary objective to reduce a budget deficit.

The first main result of this paper was that action-based fiscal consolidations are significantly affected by plausibly exogenous variables that have a contemporaneous effect on GDP growth. Temperature changes, GDP growth of trading partners, and an international commodity price index – all three of these variables have individually a significant negative contemporaneous effect on the magnitude of action-based fiscal consolidations. And, in the same sample where these variables have a significant negative effect on action-based fiscal consolidations, they have individually a significant positive effect on GDP growth. The reduced-form analysis suggested that action-based fiscal consolidations are unlikely to fulfill the condition of contemporaneous exogeneity that is required for consistent OLS estimation of the effects that fiscal consolidations have on GDP growth.

I proposed that the simultaneous system of two equations, where GDP growth affects the magnitude of fiscal consolidations and vice versa, can be identified by making exclusion restrictions. If these exclusion restrictions hold, and the instruments are relevant, then IV estimation of the system yields consistent estimates. The second and third main contribution of this paper was to provide such instrumental variables estimates.

My instrumental variables estimates showed that GDP growth has a significant negative effect on action-based fiscal consolidations. On average, a one percentage point increase in annual

GDP growth decreases the magnitude of action-based fiscal consolidations by about 0.08 percent of GDP in the same year. In the two-stage least squares regressions the instruments for GDP growth were temperature changes, GDP growth of trading partners, and the international commodity price index. Importantly, I documented that any one of these instruments yields the result that GDP growth has a significant negative effect on action-based fiscal consolidations.

An explanation for why there is a negative contemporaneous effect of GDP growth on the magnitude of action-based fiscal consolidations is that GDP growth has a positive effect on the budget balance due to automatic stabilizers. An increase in GDP growth automatically leads to an increase in tax revenues because of the way the tax system is designed. An increase in GDP growth automatically decreases government expenditures because, due to institutional design, there is a decrease in unemployment and welfare payments. Consequently, for any given desired decrease of the budget deficit: the policy maker has to increase tax rates less, and cut back less on discretionary expenditures the faster is GDP growth. This mechanism has been completely overlooked by the fiscal policy literature that applied the narrative approach.

The results from my IV analysis are completely opposite to the results of previous literature. My instrumental variables estimates showed that action-based fiscal consolidations have a significant positive effect on GDP growth. Previous literature, that used OLS regressions, found negative effects of action-based fiscal consolidations on GDP growth. I confirmed this for the most up-to-date data on GDP growth: OLS yields negative effects of action-based fiscal consolidations on GDP growth. However, OLS estimates of the effects of action-based fiscal consolidations on GDP growth are downward-biased. This is because GDP growth has a negative contemporaneous effect on the magnitude of fiscal consolidations. My IV estimates of the effects of action-based fiscal consolidations on GDP growth do not suffer from this negative reverse causality bias.

Policy makers with a low present-bias are more likely to implement fiscal consolidations than policy makers with a relatively high present-bias. The larger the present-bias, the larger the distortions. This may explain why action-based fiscal consolidations have a positive effect on GDP growth. Consistent with this explanation, I showed that action-based fiscal consolidations have a significant positive effect on total factor productivity growth.

References

Acemoglu, D., S. Johnson, J. Robinson, and P. Yared (2008). “Income and Democracy.” *American Economic Review* 98: 808-842.

Alesina, A., C. Favero, and F. Giavazzi (2015). "The output effect of fiscal consolidation plans." *Journal of International Economics* 96: S19-S42.

Alesina, A., C. Favero, and F. Giavazzi. (2018) “What Do We Know about the Effects of Austerity?” *AEA Papers and Proceedings*, 108, 524–30.

Angrist, J. and Pischke, J.-S. (2009). *Mostly Harmless Econometrics: An Empiricists Guide*. Princeton: Princeton University Press.

Blanchard O, and R. Perotti (2002). “An empirical characterization of the dynamic effects of changes in government spending and taxes on output." *Quarterly Journal of Economics* 117: 1329–1368.

Burke, M., S. Hsiang, and E. Miguel (2015b). "Global non-linear effect of temperature on economic production." *Nature* 527:235–239.

Brueckner, M., A. Chong, and M. Gradstein (2012). "Estimating the permanent income elasticity of government expenditures: Evidence on Wagner's law based on oil price shocks," *Journal of Public Economics,* Elsevier, vol. 96(11), pages 1025-1035.

Brueckner, M. (2012). "An instrumental variables approach to estimating tax revenue elasticities: Evidence from Sub-Saharan Africa," *Journal of Development Economics*, Elsevier, vol. 98(2), pages 220-227.

Cloyne, J., O. Jorda, and A. Taylor (2020). "Decomposing the Fiscal Multiplier." NBER Working Paper 26939.

David, A. And D. Leigh (2018). "A New Action-Based Dataset of Fiscal Consolidation in Latin America and the Caribbean." IMF Working Papers 18/94. International Monetary Fund.

DeVries, P., Guajardo, J., Leigh, D., and A. Pescatori (2011). "A new action-based dataset of fiscal consolidation." IMF Working Paper No. 11/128. International Monetary Fund.

Dell, M., B. Jones, and B. Olken (2012). "Temperature Shocks and Economic Growth: Evidence from the Last Half Century," *American Economic Journal: Macroeconomics*, American Economic Association, vol. 4(3), pages 66-95, July.

Fatas, A. and I. Mihov (2001). "Government size and automatic stabilizers: international and intranational evidence." *Journal of International Economics* 55: 3-28.

Feenstra, R., R. Inklaar and M. Timmer (2015). "The Next Generation of the Penn World Table." *American Economic Review* 105(10), 3150-3182,

Fernandez, A., S. Schmitt-Grohe, and M.Uribe (2017). "World shocks, world prices, and business cycles: An Empirical Investigation." *Journal of International Economics* 108, May 2017, S2-S14.

Galeano, L., A. Izquierdo, J. Puig, C. Vegh, and G. Vulletin (2021). "Can Automatic Government Spending Be Procyclical?" NBER Working Paper 28521.

Gallic, E. And G. Vermandel (2020). Weather Shocks. *European Economic Review* 124 (C)

Guajardo, J., Leigh, D., Pescatori, A. (2014). "Expansionary Austerity? International Evidence." *J. Eur. Econ. Assoc.* 12 (4), 949–968.

Gruss, B. and S. Kebhaj (2019). "Commodity Terms of Trade: A New Database." IMF Working Paper No. 19/21

Hallac, M. and P. Yared (2014). "Fiscal Rules and Discretion Under Persistent Shocks." *Econometrica* 82: 1557-1614.

Hausman, J., W. Newey, W. Taylor (1987). "Efficient Estimation and Identification of Simultaneous Equation Models with Covariance Restrictions". Econometrica 55, No. 4 (Jul., 1987), pp. 849-874.

Jordà, O. and A.M. Taylor. (2016) "The Time for Austerity: Estimating the Average Treatment Effect of Fiscal Policy." *Economic Journal*, 126, 219–55.

Kose, M.A. (2002). "Explaining business cycles in small open economies: how much do world prices matter?" *Journal of International Economics* 56: 299-327.

Lewis-Beck, M. and M. Stegmaier (2000). "Economic Determinants of Electoral Outcomes." *Annual Review of Political Science*. 3: 183-219.

Montiel O., J. Luis, and M. Plagborg-Møller. Forthcoming. "Local Projection Inference is Simpler and More Robust Than You Think." *Econometrica*.

Morris, S. and H.S. Shin (2002). "Social Value of Public Information." *American Economic Review* 92: 1521-1534.

Mountford, A. and H. Uhlig (2009). "What are the Effects of Fiscal Policy Shocks?" *Journal of Applied Econometrics* 24: 960-992.

Plagborg-Møller, M., and C. K. Wolf. (2021). "Local Projections and VARs Estimate the Same Impulse Responses." *Econometrica* 89 (2): 955-980.

Ramey, V. (2010). Discussion of "Will "Will It Hurt? Macroeconomic Effects of Fiscal Consolidations" by Guajardo, Leigh and Pescatori, NBER Monetary Economics Conference, November 2010.

Ramey, V. (2011). "Identifying Government Spending Shocks: It's All in the Timing." Q.J.E. 126 (1): 51–102.

Ramey, V. (2016). "Macroeconomic Shocks and Their Propagation." In *Handbook of Macroeconomics*, edited by John B. Taylor and Harald Uhlig, Vol. 2A, Chapter 2, pp. 71–162. North Holland: Amsterdam.

Ramey, V. and S. Zubairy (2018). "Government Spending Multipliers in Good Times and in Bad: Evidence from US Historical Data." *Journal of Political Economy* 126: 850-901.

Ramey, V. (2019). "Ten Years After the Financial Crisis: What Have We Learned from the Renaissance in Fiscal Research?" *Journal of Economic Perspectives* 33: 89-114.

Romer, C. and D. Romer. (2010) "The Macroeconomic Effects of Tax Changes: Estimates Based on a New Measure of Fiscal Shocks.” *American Economic Review*, 100: 763–801.

Roodman, D., J. MackKinnon, M. Nielsen, M. Webb (2019). “Fast and Wild: Bootstrap Inference in Stata Using Boottest.” Stata Journal 19: 4-60.

Stock, J. and M. Watson (2018). "Identification and Estimation of Dynamic Causal Effects in Macroeconomics Using External Instruments." *Economic Journal* 128: 917-948.

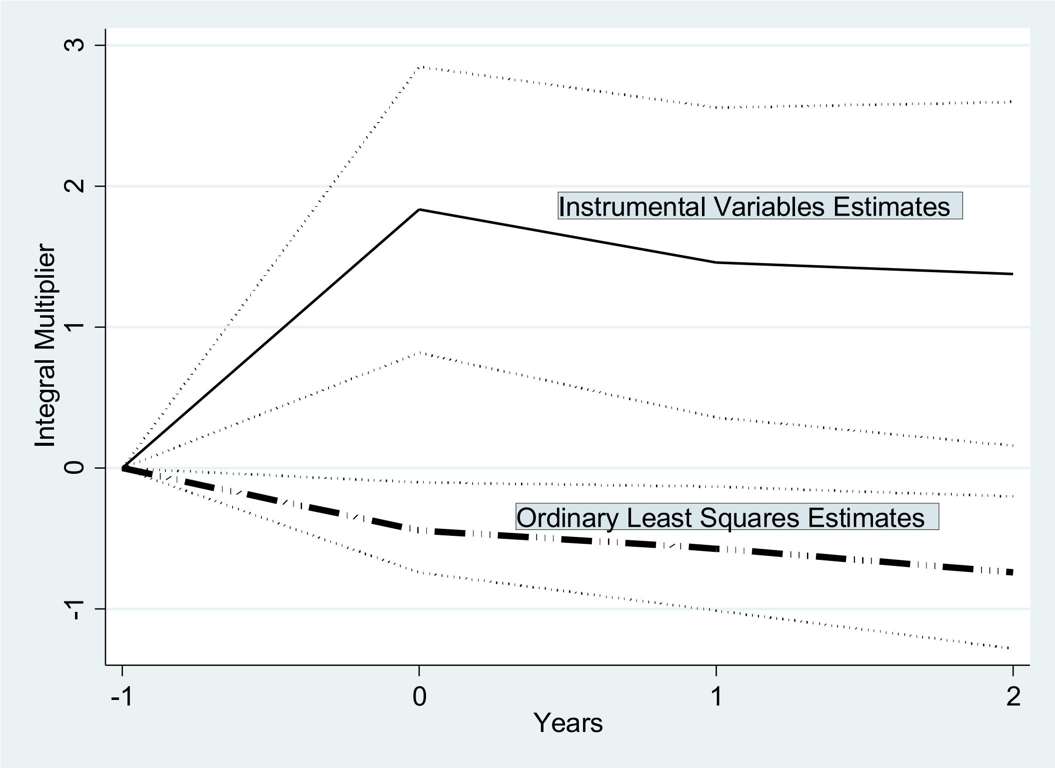
Vegh, C. and G. Vulletin (2015). "How Is Tax Policy Conducted over the Business Cycle?" *American Economic Journal: Economic Policy* 7: 327-370.

Wooldridge, J. (2010). *Econometric Analysis of Cross Section and Panel Data.* MIT Press.

World Bank (2021). World Development Indicators. Online Database. Available for download from the World Bank website https://databank.worldbank.org/source/world-development-indicators

Yared, P. (2019). "Rising Government Debt: Causes and Solutions for a Decades-Old Trend." *Journal of Economic Perspectives* 33: 115-140.

Figure 1. Estimated Effect of a 1% of GDP Fiscal Consolidation on Real GDP



Note: The figure shows estimates of the coefficients β^h in equation (2) on page 30. The letter h in the superscript refers to the horizon in years. The solid line in the above figure are the β^h coefficients obtained from instrumental variables regressions. The thick, long-dash-dotted lines are the β^h coefficients obtained from ordinary least squares regressions. The thin, tight-dotted lines are 95% confidence bands.

Table 1. Contemporaneous Effects of Temperature Changes on Fiscal Consolidations and GDP Growth

	Fiscal Consolidation	Fiscal Consolidation	GDP Growth	GDP Growth
	(1)	(2)	(3)	(4)
	Whole Sample	Excluding Large Economies	Whole Sample	Excluding Large Economies
Temperature Change, t	-0.07** (0.04)	-0.10** (0.04)	0.71*** (0.20)	0.75*** (0.22)
Country Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
Observations	986	805	986	805
Countries	31	26	31	26

Note: The dependent variable in columns (1) and (2) is *Fiscal Consolidation* in year t; in columns (3) and (4) the dependent variable is *GDP growth* in year t. The method of estimation is least squares. Columns (1) and (3) show estimates for the whole sample; columns (2) and (4) show estimates for the sub-sample that excludes France, Germany, Japan, United Kingdom, and United States. Huber robust standard errors (shown in parentheses) are clustered at the country level. *Significantly different from zero at the 10 percent level; **5 percent level; *1 percent level.

Table 2. Contemporaneous Effects of GDP Growth of Trading Partners on Fiscal Consolidations and GDP Growth

	Fiscal Consolidation	Fiscal Consolidation	GDP Growth	GDP Growth
	(1)	(2)	(3)	(4)
	Whole Sample	Excluding Large Economies	Whole Sample	Excluding Large Economies
GDP Growth of Trading Partners, t	-0.25*** (0.08)	-0.25*** (0.09)	2.65*** (0.45)	2.61*** (0.46)
Country Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
Observations	913	733	913	733
Countries	30	25	30	25

Note: The dependent variable in columns (1) and (2) is *Fiscal Consolidation* in year t; in columns (3) and (4) the dependent variable is *GDP growth* in year t. The method of estimation is least squares. Columns (1) and (3) show estimates for the whole sample; columns (2) and (4) show estimates for the sub-sample that excludes France, Germany, Japan, United Kingdom, and United States. Huber robust standard errors (shown in parentheses) are clustered at the country level. *Significantly different from zero at the 10 percent level; **5 percent level; *1 percent level.

Table 3. Contemporaneous Effects of an International Commodity Price Index on Fiscal Consolidations and GDP Growth

	Fiscal Consolidation	Fiscal Consolidation	GDP Growth	GDP Growth
	(1)	(2)	(3)	(4)
	Whole Sample	Excluding Large Economies	Whole Sample	Excluding Large Economies
Commodity Price Index, t	-0.02** (0.01)	-0.02** (0.01)	0.20*** (0.06)	0.18*** (0.07)
Country Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
Observations	908	728	908	728
Countries	30	25	30	25

Note: The dependent variable in columns (1) and (2) is *Fiscal Consolidation* in year t; in columns (3) and (4) the dependent variable is *GDP growth* in year t. The method of estimation is least squares. Columns (1) and (3) show estimates for the whole sample; columns (2) and (4) show estimates for the sub-sample that excludes France, Germany, Japan, United Kingdom, and United States. Huber robust standard errors (shown in parentheses) are clustered at the country level. *Significantly different from zero at the 10 percent level; **5 percent level; *1 percent level.

Table 4. Contemporaneous Effects of GDP Growth on Fiscal Consolidations
(Two-Stage Least Squares with Three Instruments for GDP Growth)

	Fiscal Consolidation (Tax and Expenditure)	Fiscal Consolidation (Tax and Expenditure)	Fiscal Consolidation (Tax)	Fiscal Consolidation (Tax)	Fiscal Consolidation (Expenditure)	Fiscal Consolidation (Expenditure)
	(1)	(2)	(3)	(4)	(5)	(6)
	Whole Sample	Excluding Large Economies	Whole Sample	Excluding Large Economies	Whole Sample	Excluding Large Economies
GDP Growth, t	-0.07** (0.02)	-0.08*** (0.03)	-0.05** (0.02)	-0.05** (0.02)	-0.03** (0.01)	-0.03* (0.02)
Cragg Donald F-Stat	19.7	13.9	19.7	13.9	19.7	13.9
Kleibergen Paap F-Stat	17.0	13.7	17.0	13.7	17.0	13.7
Hansen J, p-value	0.99	0.75	0.87	0.79	0.63	0.37
	First Stage Estimates for GDP Growth, t					
GDP Growth of Trading Partners, t	2.21*** (0.51)	2.13*** (0.52)	2.21*** (0.51)	2.13*** (0.52)	2.21*** (0.51)	2.13*** (0.52)
Commodity Price Index, t	0.17** (0.07)	0.14* (0.07)	0.17** (0.07)	0.14* (0.07)	0.17** (0.07)	0.14* (0.07)
Temperature Change, t	0.71*** (0.22)	0.71*** (0.26)	0.71*** (0.22)	0.71*** (0.26)	0.71*** (0.22)	0.71*** (0.26)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	850	670	850	670	850	670
Countries	29	24	29	24	29	24

Note: The method of estimation is two-stage least squares. Huber robust standard errors (shown in parentheses) are clustered at the country level. Columns (1), (3), and (5) show estimates for the whole sample; columns (2), (4), and (6) show estimates for the sub-sample that excludes France, Germany, Japan, United Kingdom, and United States.
*Significantly different from zero at the 10 percent level; **5 percent level; *1 percent level.

Table 5. Contemporaneous Effects of GDP Growth on Fiscal Consolidations
(Two-Stage Least Squares with One Instrument for GDP Growth)

	Fiscal Consolidation					
	(1)	(2)	(3)	(4)	(5)	(6)
	Whole Sample	Excluding Large Economies	Whole Sample	Excluding Large Economies	Whole Sample	Excluding Large Economies
GDP Growth, t	-0.09*** (0.03)	-0.10*** (0.03)	-0.08** (0.04)	-0.10** (0.05)	-0.10* (0.05)	-0.14** (0.06)
Cragg Donald F-Stat	48.8	13.7	27.9	13.7	8.7	7.0
Kleibergen Paap F-Stat	33.65	13.9	9.10	13.9	12.9	11.1
	First Stage Estimates for GDP Growth, t					
GDP Growth of Trading Partners, t	2.65*** (0.45)	2.61*** (0.45)				
Commodity Price Index, t			0.20*** (0.07)	0.18*** (0.07)		
Temperature Change, t					0.71*** (0.19)	0.75*** (0.22)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	913	733	908	728	990	670
Countries	30	24	30	25	31	24

Note: The dependent variable is *Fiscal Consolidation* in year t. The method of estimation is two-stage least squares. Huber robust standard errors (shown in parentheses) are clustered at the country level. Columns (1), (3), and (5) show estimates for the whole sample; columns (2), (4), and (6) show estimates for the sub-sample that excludes France, Germany, Japan, United Kingdom, and United States. *Significantly different from zero at the 10 percent level; **5 percent level; *1 percent level.

Table 6. Contemporaneous Effects of GDP Growth on Fiscal Consolidations
(Examination of the Exclusion Restrictions)

	Fiscal Consolidation					
	(1)	(2)	(3)	(4)	(5)	(6)
		Whole Sample			Excluding Large Economies	
GDP Growth, t	-0.08***	-0.09*	-0.07**	-0.08**	-0.11**	-0.07**
	(0.02)	(0.05)	(0.03)	(0.02)	(0.06)	(0.03)
Temperature Change, t	0.01			-0.01		
	(0.04)			(0.04)		
GDP Growth of Trading Partners, t		0.04			0.10	
		(0.17)			(0.20)	
Commodity Price Index, t			-0.00			-0.01
			(0.01)			(0.01)
Hansen J, p-value	0.73	0.68	0.98	0.61	0.86	0.61
Cragg Donald F-Stat	29.3	11.1	21.7	20.9	7.3	17.0
Kleibergen Paap F-Stat	16.1	10.4	23.0	14.0	7.4	21.0
	First Stage Estimates for GDP Growth					
Temperature Change, t		0.73***	0.73***		0.74***	0.74***
		(0.21)	(0.21)		(0.25)	(0.25)
GDP Growth of Trading Partners, t	2.28***		2.28***	2.25***		2.25***
	(0.47)		(0.47)	(0.49)		(0.49)
Commodity Price Index, t	0.16***	0.16**		0.13*	0.13*	
	(0.07)	(0.07)		(0.07)	(0.07)	
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	882	882	882	702	702	702
Countries	30	30	30	25	25	25

Note: The dependent variable is *Fiscal Consolidation* in year t. The method of estimation is two-stage least squares. Huber robust standard errors (shown in parentheses) are clustered at the country level. Columns (1)-(3) show estimates for the whole sample; columns (4)-(6) show estimates for the sub-sample that excludes France, Germany, Japan, United Kingdom, and United States. *Significantly different from zero at the 10 percent level; **5 percent level; *1 percent level.

Table 7. Contemporaneous Effects of GDP Growth on Fiscal Consolidations
(Dynamic Model)

	Fiscal Consolidation					
	(1)	(2)	(3)	(4)	(5)	(6)
	Whole Sample			Excluding Large Economies		
GDP Growth, t	-0.08***	-0.07***	-0.07***	-0.09***	-0.08***	-0.08***
	(0.03)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)
CONTROL VARIABLES						
Fiscal Consolidations, t-1	0.40***	0.40***	0.40***	0.40***	0.41***	0.41***
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Fiscal Consolidations, t-2	-0.00	0.01		-0.00	0.01	
	(0.07)	(0.06)		(0.07)	(0.07)	
GDP Growth, t-1	0.02			0.02		
	(0.01)			(0.01)		
GDP Growth, t-2	-0.02**			-0.02**		
	(0.01)			(0.01)		
Hansen J, p-value	0.97	0.99	0.98	0.89	0.72	0.83
Cragg Donald F-Stat	13.0	20.4	22.0	9.4	14.7	15.5
Kleibergen Paap F-Stat	14.0	13.7	13.8	12.6	12.4	12.1
	First Stage Estimates for GDP Growth, t					
Temperature Change	0.60***	0.60***	0.58***	0.63***	0.60***	0.59**
	(0.20)	(0.21)	(0.21)	(0.24)	(0.26)	(0.26)
GDP Growth of Trading Partners	1.64***	2.16***	2.04***	1.61***	2.14***	1.99***
	(0.37)	(0.49)	(0.49)	(0.38)	(0.51)	(0.51)
Commodity Price Index	0.14**	0.20***	0.22***	0.13*	0.18**	0.20***
	(0.07)	(0.07)	(0.06)	(0.07)	(0.07)	(0.06)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	797	797	824	627	627	649
Countries	29	29	29	24	24	24

Note: The dependent variable is *Fiscal Consolidation* in year t. The method of estimation is two-stage least squares. Huber robust standard errors (shown in parentheses) are clustered at the country level. Columns (1)-(3) show estimates for the whole sample; columns (4)-(6) show estimates for the sub-sample that excludes France, Germany, Japan, United Kingdom, and United States. *Significantly different from zero at the 10 percent level; **5 percent level; *1 percent level.

Table 8. Contemporaneous Effects of GDP Growth on Fiscal Consolidations
(At Different Time Horizons)

	Fiscal Consolidation(*h*)					
	(1)	(2)	(3)	(4)	(5)	(6)
	h=0	*h=1*	*h=2*	*h=0*	*h=1*	*h=2*
		Whole Sample			Excluding Large Economies	
GDP Growth(*h*)	-0.08***	-0.07***	-0.07***	-0.09***	-0.06***	-0.06***
	(0.03)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)
CONTROL VARIABLES						
Fiscal Consolidation, t-1	0.40***	0.53**	0.54***	0.41***	0.55**	0.56***
	(0.05)	(0.11)	(0.13)	(0.05)	(0.12)	(0.14)
Fiscal Consolidation, t-2	-0.00	-0.02	-0.00	-0.00	-0.03	-0.01
	(0.06)	(0.07)	(0.07)	(0.06)	(0.07)	(0.07)
GDP Growth, t-1	0.02	0.01	-0.01	0.02	-0.00	-0.02
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
GDP Growth, t-2	-0.02**	-0.03**	-0.04***	-0.02**	-0.04***	-0.05***
	(0.00)	(0.01)	(0.02)	(0.00)	(0.02)	(0.02)
	First Stage Estimates for GDP Growth(*h*)					
Temperature Change (*h*)	0.60***	0.76**	1.41***	0.63***	0.68*	1.21**
	(0.20)	(0.37)	(0.54)	(0.24)	(0.40)	(0.06)
GDP Growth of Trading Partners (*h*)	1.64***	2.35***	3.01***	1.61***	2.34***	3.08***
	(0.37)	(0.56)	(0.73)	(0.38)	(0.57)	(0.74)
Commodity Price Index (*h*)	0.14**	0.21***	0.22***	0.13*	0.19***	0.20***
	(0.07)	(0.07)	(0.08)	(0.07)	(0.07)	(0.07)
Cragg Donald F-Stat	14.0	16.5	19.1	9.4	15.9	23.01
Kleibergen Paap F-Stat	13.0	22.7	32.1	12.6	16.5	23.76
Hansen J, p-value	0.97	0.58	0.42	0.89	0.43	0.27
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	797	768	739	627	603	579
Countries	29	29	29	24	24	24

Note: The dependent variable is *Fiscal Consolidation(h)* where *h* refers to the horizon, h=0, 1, 2. The method of estimation is two-stage least squares. Huber robust standard errors (shown in parentheses) are clustered at the country level. Columns (1)-(3) show estimates for the whole sample; columns (4)-(6) show estimates for the sub-sample that excludes France, Germany, Japan, United Kingdom, and United States. *Significantly different from zero at the 10 percent level; **5 percent level; *1 percent level.

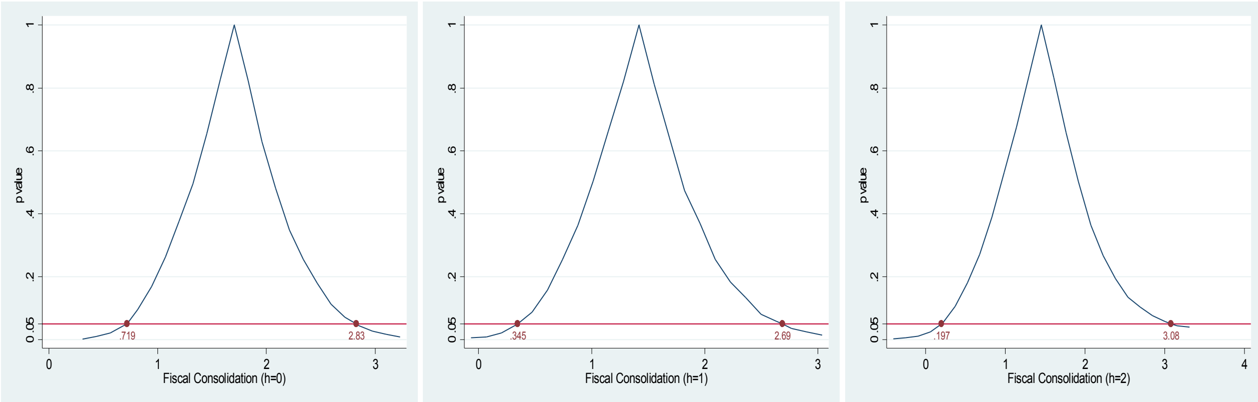
Table 9. The Response of GDP Growth to Fiscal Consolidations

	GDP Growth(*h*)					
	(1)	(2)	(3)	(4)	(5)	(6)
	h=0	h=1	h=2	t=0	t=1	t=2
		Whole Sample			Excluding Large Economies	
			Panel A: Two-Stage Least Squares			
Fiscal Consolidation(*h*)	1.84***	1.46***	1.38**	2.00***	1.61***	1.52**
	(0.51)	(0.55)	(0.61)	(0.58)	(0.62)	(0.70)
			[Wild Restricted Efficient Cluster Bootstrapped 95% Confidence Interval]			
	[0.72, 2.83]	[0.35, 2.69]	[0.20, 3.08]	[0.67, 3.26]	[0.31, 3.01]	[0.11, 3.49]
			First Stage for Fiscal Consolidation(*h*)			
u^{res}	0.88***	0.91***	0.91***	0.86***	0.90***	0.89***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.05)
Cragg Donald F-Stat	4253.7	5376.2	4590.9	2878.5	3467.7	2830.2
Kleibergen Paap F-Stat	807.4	887.7	633.0	550.9	569.5	378.2
			Panel B: Least Squares			
Fiscal Consolidation (*h*)	-0.44***	-0.57**	-0.74***	-0.45**	-0.60**	-0.80***
	(0.15)	(0.22)	(0.27)	(0.19)	(0.24)	(0.28)
			Controls and Observations in Panels A and B			
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	827	797	767	657	632	607
Countries	30	30	30	25	25	25

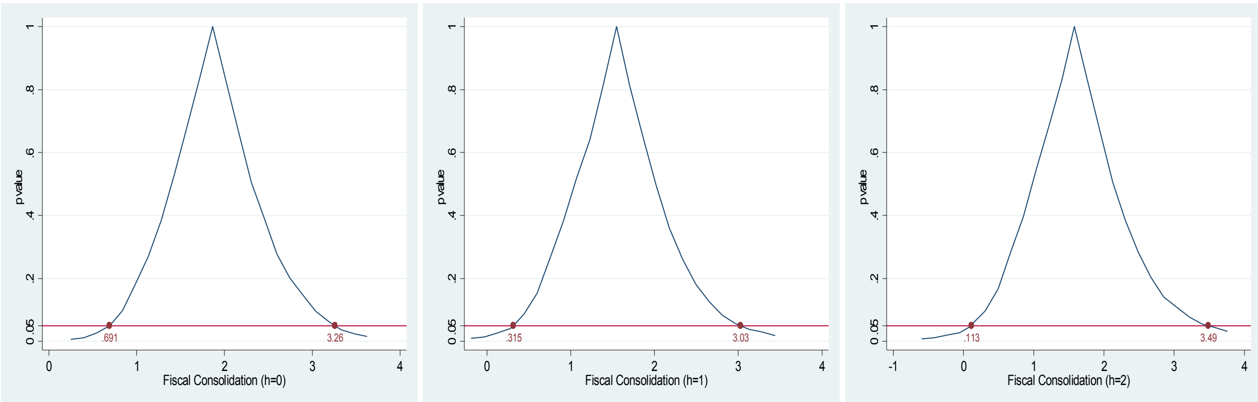
Note: The method of estimation in Panel A is two-stage least squares; Panel B least squares. Robust standard errors (shown in parentheses) are clustered at the country level. The 95% confidence intervals [shown in square brackets] are obtained using the wild restricted efficient bootstrap with 1000 draws, clustered at the country level; the auxiliary random variable was drawn from a Rademacher distribution; bootstrapping was done over the t-statistic. The endogenous variable in Panel A is *FiscalConsolidation(h)*, where the *h* refers to the horizon, *h*=0, 1, 2. The instrument is the residual variation in *FiscalConsolidation(h)* that is not due to *GDPGrowth(h),* i.e. u^{res}=*FiscalConsolidation(h)*-α^{IV}*GDPGrowth(h)* where α^{IV} is the estimated IV coefficient on *GDPGrowth(h)* from Table 8. Additional controls, estimates not reported, are GDP growth in *t*-1 and *t*-2, fiscal consolidations in *t*-1 and *t*-2, and, computed for each horizon *h*=0, 1, 2, temperature changes(h), GDP growth of trading partners(h), and the international commodity price index(h).

Appendix Figure 1. Confidence Curves

Panel A: Whole Sample



Panel B: Sample that Excludes the 5 Largest Economies



Note. The confidence curves are for the IV regressions of Panel A in Table 9. The confidence curves were generated using a wild restricted efficient bootstrap with 1000 draws, clustered at the country level; the auxiliary random variable for the bootstrapping was drawn from a Rademacher distribution. Panel A (B) of Appendix Figure 1 shows the confidence curves for the whole sample (sample that excludes the 5 largest economies).

Appendix Table 1. Descriptive Statistics

Variable	Source	Mean	Stdv.	Obs.
Fiscal Consolidation	DeVries et al. (2011); David and Leigh (2018)	0.32	0.74	1016
Tax-based	DeVries et al. (2011); David and Leigh (2018)	0.15	0.44	984
Expenditure-based	DeVries et al. (2011); David and Leigh (2018)	0.16	0.44	984
Temperature Change	FAOSTAT (2021)	0.68	0.60	994
Temperature Change	Dell et al. (2012)	0.03	0.65	745
GDP Growth of Trading Partners	Vegh and Vulletin (2015)	0.66	0.51	913
Commodity Price Index	Vegh and Vulletin (2015)	0.83	3.62	908
Commodity Price Index	Gruss and Kebhaj (2019)	100.5	3.99	995
Terms of Trade	World Bank (2021)	99.6	18.5	1012
GDP Growth	PWT version 10.0	3.41	4.24	1016
Total Factor Productivity Growth	PWT version 10.0	0.39	2.11	1016
Investment Growth	PWT version 10.0	3.46	10.7	1016
Consumption Growth	PWT version 10.0	3.31	3.75	1016
Change in GDP Share of Net Exports	PWT version 10.0	-0.02	3.27	1016
Inflation	PWT version 10.0	2.82	10.15	1016
Real Effective Exchange Rate Growth	World Bank (2021)	-0.08	617.0	836
GDP Share of Tax Revenues	Vegh and Vulletin (2015)	21.8	8.8	793
GDP Share of Government Expenditures	PWT version 10.0	16.0	4.3	1016

Appendix Table 2. Robustness: Temperature Data from Dell et al. (2012)

	Fiscal Consolidation	Fiscal Consolidation	GDP Growth	GDP Growth
	(1)	(2)	(3)	(4)
	Whole Sample	Excluding Large Economies	Whole Sample	Excluding Large Economies
Temperature Change, t (Dell et al., 2012 data)	-0.07** (0.04)	-0.10** (0.04)	0.78*** (0.22)	0.92*** (0.25)
Country Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
Observations	745	600	745	600
Countries	31	26	31	26

Note: The dependent variable in columns (1) and (2) is *Fiscal Consolidation* in year *t*; in columns (3) and (4) the dependent variable is *GDP growth* in year *t*. The method of estimation is least squares. Columns (1) and (3) show estimates for the whole sample; columns (2) and (4) show estimates for the sub-sample that excludes France, Germany, Japan, United Kingdom, and United States. *Significantly different from zero at the 10 percent level; **5 percent level; *1 percent level.

Appendix Table 3. Robustness: International Commodity Price Index from Gruss and Kebhaj (2019)

	Fiscal Consolidation	Fiscal Consolidation	GDP Growth	GDP Growth
	(1)	(2)	(3)	(4)
	Whole Sample	Excluding Large Economies	Whole Sample	Excluding Large Economies
Commodity Price Index, t (Gruss and Kebhaj, 2019)	-0.03* (0.02)	-0.03* (0.02)	0.31*** (0.09)	0.28*** (0.09)
Country Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
Observations	995	810	995	810
Countries	31	26	31	26

Note: The dependent variable in columns (1) and (2) is *Fiscal Consolidation* in year *t*; in columns (3) and (4) the dependent variable is *GDP growth* in year *t*. The method of estimation is least squares. Columns (1) and (3) show estimates for the whole sample; columns (2) and (4) show estimates for the sub-sample that excludes France, Germany, Japan, United Kingdom, and United States. *Significantly different from zero at the 10 percent level; **5 percent level; *1 percent level.

Appendix Table 4. Robustness: Net Barter Terms of Trade from the World Bank (2021)

	Fiscal Consolidation	Fiscal Consolidation	GDP Growth	GDP Growth
	(1)	(2)	(3)	(4)
	Whole Sample	Excluding Large Economies	Whole Sample	Excluding Large Economies
Terms of Trade, t	-0.006** (0.003)	-0.006** (0.003)	0.097** (0.044)	0.092** (0.046)
Country Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
Observations	1008	823	1008	823
Countries	31	26	31	26

Note: The dependent variable in columns (1) and (2) is *Fiscal Consolidation* in year *t*; in columns (3) and (4) the dependent variable is *GDP growth* in year *t*. The method of estimation is least squares. Columns (1) and (3) show estimates for the whole sample; columns (2) and (4) show estimates for the sub-sample that excludes France, Germany, Japan, United Kingdom, and United States. *Significantly different from zero at the 10 percent level; **5 percent level; *1 percent level.

Appendix Table 5. Poisson Estimates

	Fiscal Consolidation							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Whole Sample				Excluding Large Economies			
Temperature Change, t	-0.22** (0.11)			-0.18* (0.10)	-0.29*** (0.10)			-0.22** (0.09)
GDP Growth of Trading Partners, t		-0.82*** (0.25)		-0.62** (0.29)		-0.86*** (0.26)		-0.64** (0.30)
Commodity Price Index, t			-0.09** (0.04)	-0.08* (0.04)			-0.09** (0.04)	-0.08* (0.04)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	888	789	768	764	777	681	660	656

Note: Fixed effects Poisson model estimates. The dependent variable is *Fiscal Consolidation* in year *t*. In parentheses are Huber robust errors which are clustered at the country level. Columns (1)-(4) show estimates for the whole sample; columns (5)-(8) show estimates for the sub-sample that excludes France, Germany, Japan, United Kingdom, and United States. *Significantly different from zero at the 10 percent level; **5 percent level; *1 percent level.

Appendix Table 6. System-GMM Estimates

	Fiscal Consolidation					
	(1)	(2)	(3)	(4)	(5)	(6)
		Whole Sample			Excluding Large Economies	
			Panel A: System-GMM			
GDP Growth, t	-0.06*** (0.02)	-0.06*** (0.02)	-0.08*** (0.02)	-0.06*** (0.02)	-0.06*** (0.03)	-0.08*** (0.03)
CONTROL VARIABLES						
Fiscal Consolidations, t-1	0.80*** (0.30)	0.84*** (0.29)	0.66*** (0.20)	0.89*** (0.29)	0.95*** (0.28)	0.71*** (0.21)
Fiscal Consolidations, t-2	-0.12 (0.16)	-0.13 (0.15)		-0.19 (0.15)	-0.21 (0.14)	
GDP Growth, t-1	0.00 (0.01)			0.00 (0.01)		
GDP Growth, t-2	-0.01 (0.01)			-0.01 (0.01)		
AR (1) test, p-value	0.03	0.02	0.00	0.02	0.01	0.00
AR (2) test, p-value	0.50	0.48	0.83	0.32	0.29	0.75
Sargan test, p-value	0.43	0.52	0.29	0.54	0.66	0.29
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	797	797	824	627	627	649
Countries	29	29	29	24	24	24

Note: The dependent variable is *Fiscal Consolidation* in year *t*. The method of estimation is system-GMM. GMM-style instruments for fiscal consolidations in *t*-1 and *t*-2 are third and higher order lags. GDP growth in year *t* is specified as an endogenous variable: the instrument set includes temperature changes, GDP growth rate of trading partners, and the international commodity price index. GDP growth in *t*-1 and *t*-2 is specified as a pre-determined variable. In parentheses are Huber robust errors clustered at the country level. Columns (1)-(3) show estimates for the whole sample; columns (4)-(6) show estimates for the sub-sample that excludes France, Germany, Japan, United Kingdom, and United States. *Significantly different from zero at the 10 percent level; **5 percent level; *1 percent level.

Appendix Table 7. Difference-GMM Estimates

	Fiscal Consolidation					
	(1)	(2)	(3)	(4)	(5)	(6)
		Whole Sample			Excluding Large Economies	
GDP Growth, t	-0.08*** (0.02)	-0.08*** (0.03)	-0.08*** (0.03)	-0.08*** (0.02)	-0.07** (0.03)	-0.08*** (0.03)
CONTROL VARIABLES						
Fiscal Consolidations, t-1	0.45 (0.28)	0.58* (0.31)	0.48*** (0.22)	0.59** (0.27)	0.74** (0.29)	0.57*** (0.22)
Fiscal Consolidations, t-2	-0.08 (0.18)	-0.10 (0.16)		-0.15 (0.16)	-0.19 (0.13)	
GDP Growth, t-1	-0.03* (0.01)			-0.02* (0.01)		
GDP Growth, t-2	-0.02*** (0.01)			-0.02** (0.01)		
AR (1) test, p-value	0.03	0.04	0.01	0.02	0.01	0.01
AR (2) test, p-value	0.40	0.64	0.93	0.32	0.25	0.84
Sargan test, p-value	0.37	0.41	0.28	0.54	0.47	0.19
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	768	768	795	603	603	625
Countries	29	29	29	24	24	24

Note: The dependent variable is *Fiscal Consolidation* in year t. The method of estimation is Diff-GMM. GMM-style instruments for fiscal consolidations in *t*-1 and *t*-2 are third and higher order lags. GDP growth in year *t* is specified as an endogenous variable: the instrument set includes temperature changes, GDP growth rate of trading partners, and the international commodity price index. GDP growth in *t*-1 and *t*-2 is specified as a pre-determined variable. In parentheses are Huber robust errors clustered at the country level. Columns (1)-(3) show estimates for the whole sample; columns (4)-(6) show estimates for the sub-sample that excludes France, Germany, Japan, United Kingdom, and United States. *Significantly different from zero at the 10 percent level; **5 percent level; *1 percent level.

Appendix Table 8: Automatic Stabilizers

	GDP Share of Tax Revenues	GDP Share of Tax Revenues	GDP Share of Government Expenditures	GDP Share of Government Expenditures
	(1)	(2)	(3)	(4)
	Whole Sample	Excluding Large Economies	Whole Sample	Excluding Large Economies
GDP Growth, t	0.24**	0.32***	-0.28***	-0.29***
	(0.11)	(0.10)	(0.09)	(0.10)
Cragg Donald F-Stat	15.7	11.0	19.4	13.7
Kleibergen Paap F-Stat	16.6	12.8	17.0	13.9
Hansen J, p-value	0.18	0.15	0.34	0.33
	First Stage Estimates for GDP Growth, t			
GDP Growth of Trading Partners, t	2.02***	1.91***	2.21***	2.13***
	(0.54)	(0.55)	(0.51)	(0.52)
Commodity Price Index, t	0.16**	0.14*	0.17**	0.14*
	(0.07)	(0.08)	(0.07)	(0.07)
Temperature Change, t	0.73***	0.78***	0.71***	0.71***
	(0.21)	(0.26)	(0.22)	(0.26)
Country Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
Observations	737	577	850	670
Countries	29	24	29	24

Note: The dependent variable in columns (1) and (2) is the GDP share of total tax revenues; in columns (3) and (4) the dependent variable is the GDP share of government expenditures. The method of estimation is two-stage least squares. Columns (1) and (3) show estimates for the whole sample; columns (2) and (4) show estimates for the sub-sample that excludes France, Germany, Japan, United Kingdom, and United States. Huber robust standard errors (shown in parentheses) are clustered at the country level. *Significantly different from zero at the 10 percent level; **5 percent level; *1 percent level.

Appendix Table 9: Effects of Fiscal Consolidations on Total Factor Productivity, Investment, Consumption and Net-Exports

	Total Factor Productivity Growth	Investment Growth	Consumption Growth	Change in Net-Exports GDP Share
	(1)	(2)	(3)	(4)
	Panel A: Whole Sample			
Fiscal Consolidation, t	0.62**	2.34**	0.48	0.81***
	(0.26)	(1.08)	(0.41)	(0.24)
Cragg Donald F-Stat	3799.3	3826.8	3999.3	3840.4
Kleibergen Paap F-Stat	690.0	689.7	701.9	690.8
Observations	797	797	797	797
Countries	29	29	29	29
Country Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes	Yes
	Panel B: Excluding 5 Largest Economies			
Fiscal Consolidation, t	0.62**	2.35**	0.42	0.82***
	(0.28)	(1.15)	(0.42)	(0.25)
Cragg Donald F-Stat	2963.2	2989.8	3146.3	2997.2
Kleibergen Paap F-Stat	603.3	609.5	622.0	608.5
Observations	627	627	627	627
Countries	24	29	29	29
Country Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes	Yes

Note: The dependent variable in column (1) is the total factor productivity growth; column (2) investment growth; column (3) private consumption growth; column (4) the year *t*-1 to *t* change in the GDP share of net-exports. The method of estimation is two-stage least squares. Panel A shows estimates for the whole sample; Panel B shows estimates for the sub-sample that excludes France, Germany, Japan, United Kingdom, and United States. Huber robust standard errors (shown in parentheses) are clustered at the country level. Additional controls, estimates not reported, are the dependent variable in *t*-1 and *t*-2, GDP growth in *t*-1 and *t*-2, and fiscal consolidations in *t*-1 and *t*-2. *Significantly different from zero at the 10 percent level; **5 percent level; *1 percent level.

Appendix Table 10: Effects of Fiscal Consolidations on Inflation and the Real Exchange Rate

	Inflation	Inflation	Real Exchange Rate	Real Exchange Rate
	(1)	(2)	(3)	(4)
	Whole Sample	Excluding 5 Largest Economies	Whole Sample	Excluding 5 Largest Economies
Fiscal Consolidation, t	-2.33***	-2.44***	-0.95**	-1.10**
	(0.75)	(0.82)	(0.46)	(0.48)
Cragg Donald F-Stat	3793.9	2976.4	3604.4	2758.9
Kleibergen Paap F-Stat	676.1	600.4	918.0	893.9
Observations	797	627	674	517
Countries	29	25	25	20
Country Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes	Yes

Note: The dependent variable in columns (1) and (2) is the growth rate of the GDP price deflator; columns (3) and (4) the growth rate of the real exchange rate. The method of estimation is two-stage least squares. Columns (1) and (3) show estimates for the whole sample; columns (2) and (4) show estimates for the sub-sample that excludes France, Germany, Japan, United Kingdom, and United States. Huber robust standard errors (shown in parentheses) are clustered at the country level. Additional controls, estimates not reported, are the dependent variable in *t*-1 and *t*-2, GDP growth in *t*-1 and *t*-2, and fiscal consolidations in *t*-1 and *t*-2. *Significantly different from zero at the 10 percent level; **5 percent level; *1 percent level.

Appendix Table 11. Effects of Tax- and Expenditure-Based Consolidations on GDP Growth in Latin America and the Carribean and Advanced Economies

	GDP Growth		
	(1)	(2)	(3)
	Latin America and the Carribean	Advanced Economies	AE, Without 5 Largest Economies
		Panel A: Tax-Based	
Fiscal Consolidation, t	4.00**	0.88***	0.75***
	(1.69)	(0.23)	(0.20)
Kleibergen Paap F-Stat	197	8318	10730
		Panel B: Expenditure-Based	
Fiscal Consolidation, t	8.28***	1.17***	1.05***
	(2.92)	(0.27)	(0.27)
Kleibergen Paap F-Stat	186	15649	14396
		Observations and Controls in Panels A and B	
Observations	291	506	336
Countries	13	16	11
Country Fixed Effects	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes

Note: The dependent variable is year *t* GDP growth. The method of estimation is two-stage least squares. Column (1) shows estimates for Latin America and the Caribbean; column (2) advanced economies; column (3) advanced economies without France, Germany, Japan, United Kingdom, and United States. Panel A reports estimates of the effects that tax-based consolidations in year *t* have on GDP growth in year *t*; Panel B reports effects for expenditure-based consolidations. Huber robust standard errors (shown in parentheses) are clustered at the country level. Additional controls, estimates not reported, are GDP growth in *t*-1 and *t*-2, and fiscal consolidations in *t*-1 and *t*-2. *Significantly different from zero at the 10 percent level; **5 percent level; *1 percent level.