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FISCAL INFLUENCES ON INFLATION IN OECD COUNTRIES, 2020-2022

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ABSTRACT

The fiscal theory of the price level (FTPL) has been active for 30 years, and the interest in this theory grew with the recent global surges in inflation and government spending. This study applies the FTPL to 37 OECD countries for 2020-2022. The theory's centerpiece is the government's intertemporal budget constraint, which relates a country's inflation rate in 2020 2022 (relative to a baseline rate) to a composite government-spending variable. This variable equals the cumulative increase in the ratio of government expenditure to GDP from 2020 to 2022, divided by the ratio of public debt to GDP in 2019 and the duration of the debt in 2019. This specification has substantial explanatory power for recent inflation rates across 20 non-Euro-zone countries and an aggregate of 17 Euro-zone countries. The estimated coefficients of the composite spending variable are significantly positive, implying that 40-50% of effective government financing came from the inverse effect of unexpected inflation on the real value of public debt, whereas 50 60% reflected conventional public finance (increases in current or future taxes or cuts in future spending). Within the Euro area, inflation reacts mostly to the area-wide government-spending variable, not to individual values.

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The fiscal theory of the price level, FTPL, has been around since the early 1990s. Major contributions include Leeper (1991), Woodford (1995, 2001), Sims (1994), Dupor (2000), Cochrane (2001), and Bassetto (2002). This research was summarized and extended in the recent book by Cochrane (2023). However, despite its theoretical elegance, the FTPL was not taken seriously by mainstream macroeconomists as an empirical model of the price level and inflation until recently. This neglect arose partly because inflation has been associated much more with monetary policy and partly because the inflation rate in many countries has been low and stable from the mid-1980s until 2020. The global expansion of government spending and the accompanying surge of inflation after 2019 in the wake of the COVID crisis changed the picture. There is now broader receptivity toward the idea that, at least in extreme circumstances such as the COVID crisis, fiscal expansion can be a key driver of inflation and that the FTPL offers a coherent framework for understanding these effects.

In this study, we examine the role of fiscal expansion as a determinant of inflation rates in 37 OECD countries since 2019. We first use the key ingredients of the FTPL to work out a simple relation between inflation rates and government spending. Then we apply this specification empirically, using measures of CPI headline and core inflation rates along with information on changes in general government primary expenditure, public-debt levels, and debt duration. Our conclusion is that estimation of a well-specified equation supports the idea that the recent fiscal expansion has been a key driver of inflation rates in the OECD countries.

The framework that we apply empirically relies on a frictionless setting with no nominal rigidities, in the spirit of Cochrane (2001). In this respect, we depart from empirical work that integrates the insights of the FTPL into models with nominal rigidities to explain the evolution of inflation (Davig and Leeper [2006], Bianchi and Ilut [2017], Bianchi and Melosi [2017, 2023], Leeper, Traum, and Walker [2017]). Further, while most of the existing empirical evidence regarding the FTPL is based on U.S. data, we work instead with a cross-section of OECD countries. We show that, unlike monetary policy going back to the early 2000s, the large recent fiscal interventions related to the COVID crisis "succeeded" in generating high inflation.

I. Conceptual Framework based on the Fiscal Theory of Price Level

The centerpiece of the fiscal theory of the price level (FTPL) is the government's intertemporal budget constraint, which equates the market value of the initial real public debt to the present value of real primary surpluses:

$$\frac{B_t}{P_t} = T_t - G_t + \frac{(T_{t+1} - G_{t+1})}{1+r} + \frac{(T_{t+2} - G_{t+2})}{(1+r)^2} + \cdots \qquad (1)$$

where B_t is the nominal market value of (short-term and long-term) public debt outstanding at the beginning of period t, P_t is the price level at the start of period t, T_{t+i} and G_{t+i} are the government's real taxes and primary real spending,[1] respectively, in period $t+i$, and r is a constant real discount rate. (In our analysis, the length of the period plays no economic role and is assumed to be very short.) As is well-known, the validity of Eq. (1) depends on a no-Ponzi condition, which precludes the government financing itself in the long run through perpetual rolling-over of principal and interest on its bonds. We assume throughout that this no-Ponzi condition holds. Note that G_{t+i} is the sum of real government purchases and transfers and excludes interest payments. Equation (1) says that the outstanding stock of public debt has to be financed by a corresponding present value of real primary surpluses, although the timing of these surpluses is flexible.

[1] We do not deal here with seignorage associated with governmental issue of paper money. This seignorage can be viewed as part of the government's tax revenue.

For the application to the recent surge of inflation in OECD countries, the idea is that a rise in government spending stimulated by the COVID recession lowered the right side of Eq.(1) for most countries. In particular, the expectation was that the large, unexpected increase in spending would not be matched fully by rises in current or future revenue or reductions in future spending. Instead, the government's intertemporal budget constraint would have to be satisfied through a cut in the real market value of public debt on the left side of Eq.(1). If the public debt is denominated in domestic currency, this depreciation of the real debt could be accomplished—in the absence of formal default—by increases in current or future price levels; that is, by a sustained period of inflation that was unexpected prior to period *t*. To make these general ideas applicable to empirical estimation across countries, the analysis uses a series of simplifications that leads to a tractable functional form that can be readily implemented empirically.

Suppose that a crisis, such as the COVID pandemic, begins at the start of period *t* and features an unexpected surge in government spending that raises G_{t+i} for $i = 0, \ldots, M$. If ΔG_{t+i} denotes the increment to real spending in period $t+i$ (relative to that anticipated before date *t*), the present value of these changes is:

(2) $$\Delta G_t + \frac{\Delta G_{t+1}}{1+r} + \frac{\Delta G_{t+2}}{(1+r)^2} + \ldots + \frac{\Delta G_{t+M}}{(1+r)^M}$$

The assumption is that, after M periods, real spending returns to its previous path—that is, the higher real spending is temporary.[2] Further, the changes in real spending are assumed to be unknown before period t but fully known at the start of period t.[3]

A general analysis would include changes in real government revenue in the form of the present value:

$$\Delta T_t + \frac{\Delta T_{t+1}}{1+r} + \frac{\Delta T_{t+2}}{(1+r)^2} + \ldots + \frac{\Delta T_{t+M}}{(1+r)^M} \quad (3)$$

Again, the changes after date $t+M$ are assumed to be zero. In practice, for 2020-2022, the government spending surge dominated the changes in government revenue. For example, for general government for the 37 OECD countries considered in the empirical analysis, the cumulative rise in ratios to GDP over 2020-2022 compared to the ratio in 2019 averaged 0.122 for primary government spending and only 0.016 for government revenue. Our main analysis omits the revenue side, shown in Eq. (3), and focuses on the contribution to real primary deficits from the spending surge, shown in Eq. (2).

The analysis is carried out within the frictionless (flexible-price) version of the FTPL described by Cochrane (2001; 2023, Chs. 1-3). In particular, the paths of real GDP, Y_t, and the real interest rate, $r_t=r$, are assumed to be invariant with the fiscal/monetary shocks. More

[2]For the 37 OECD countries in the empirical analysis, the mean ratio to GDP of general government spending exclusive of interest payments is 0.385 in 2019, 0.444 in 2020, 0.426 in 2021, and 0.407 in 2022. That is, the average spending ratio rose on net by 0.022 from 2019 to 2022. The mean ratio of general government revenue to GDP is 0.394 in 2019, 0.393 in 2020, 0.401 in 2021, and 0.403 in 2022. Therefore, this average ratio rose on net by 0.009 from 2019 to 2022. The average ratio of the primary deficit to GDP rose on net by 0.013 from 2019 to 2022, going from -0.009 to 0.004. Therefore, it is plausible that the permanent change in the ratio of the primary deficit to GDP was small.

[3]Bianchi, Faccini, and Melosi (2023) argue that the extent to which fiscal shocks are unfunded—that is, not balanced by corresponding changes in future primary real deficits—is the key to the connection between fiscal expansion and inflation. Learning about the path of primary real deficits is central to the analysis of Bassetto and Miller (2023).

broadly, the assumption is that the path of inflation rates is not substantially influenced by changes that occur in real variables.

If Y_t grows at the constant rate $g=r$, the expression in Eq.(2) can be written as:

$$(4) \qquad Y_t \cdot \left[\Delta\left(\frac{G_t}{Y_t}\right) + \Delta\left(\frac{G_{t+1}}{Y_{t+1}}\right) + \cdots + \Delta\left(\frac{G_{t+M}}{Y_{t+M}}\right)\right]$$

where each term within the brackets represents a change in the ratio of primary government spending to GDP. These changes are measured relative to ratios that prevailed before period t. By assumption, $\Delta(G_{t+i}/Y_{t+i})$ is zero for $i>M$.

At time t, the aggregate amounts of nominal payouts on government bonds due at the start of each period are $B_t^0, B_t^1, \dots, B_t^T$, where T is the maximum debt maturity. Note that B_t^i represents the total of coupons and principal payments due at date $t+i$, not the amounts associated with a single bond. The total nominal market value of government bonds (short-term and long-term) outstanding at the start of period t is

$$(5) \qquad B_t = B_t^0 + \frac{B_t^1}{(1+r)(1+\pi_{t+1})} + \frac{B_t^2}{(1+r)^2(1+\pi_{t+1})(1+\pi_{t+2})} + \cdots + \frac{B_t^T}{(1+r)^T(1+\pi_{t+1})\dots(1+\pi_{t+T})}$$

where π_{t+i} is the inflation rate for period $t+i$. The assumption is that these inflation rates were unknown before period t but are fully anticipated as of the start of period t, when the path of real primary deficits also becomes known. Therefore, if R_{t+i} is the nominal interest rate for period $t+i$, this rate moves along with the inflation rate, π_{t+i}, so that $(1+R_{t+i})=(1+r)\cdot(1+\pi_{t+i})$.

To simplify the algebra, the aggregate nominal payments due on bonds are assumed to rise over time in accordance with a baseline (past) inflation rate, π^*, and the growth rate of real GDP, $g=r$. That is, the government arranges its debt composition so that the total nominal payments due rise, in the absence of shocks, along with nominal GDP. In that case, Eq.(5) becomes

(6) $$B_t = B_t^0\left[1+\frac{1+\pi*}{1+\pi_{t+1}}+\frac{(1+\pi*)^2}{(1+\pi_{t+1})(1+\pi_{t+2})}+\cdots+\frac{(1+\pi*)^T}{(1+\pi_{t+1})\ldots(1+\pi_{t+T})}\right]$$

When all (actual and expected) inflation rates equal the baseline rate, π^*, the relation between the total market value of debt and the amount of short-term debt paid off in period *t* is

(7) $$B_t^* = B_t^0 \cdot (1+T)$$

where B_t^* can be viewed as the baseline nominal value of public debt; that is, the value prior to the deviation of inflation rates from the baseline rate.

The reaction to the surge in spending from Eq.(4) is assumed to be a surge in the sequence of inflation rates, $\pi_{t+1}, \ldots, \pi_{t+T}$, above the baseline rate, π^*. The assumption is that π^* is fixed (and, thereby, pins down the long-term future inflation rate). The shifts in inflation rates, when anticipated, lower the nominal market value of bonds outstanding in accordance with Eq.(6). (This analysis rules out a jump in the price level at the start of period *t*, though that change could be introduced.) The idea is that lowering the real value of public debt effectively pays for at least part of the increase in the present value of real primary deficits in Eq.(4). The change in the nominal market value of debt generated by a shift in (actual and expected) inflation rates from π^* to the sequence $\pi_{t+1}, \ldots \pi_{t+T}$ is given from Eq.(6) by:

(8) $$\Delta B = B_t^0\left\{\left[\frac{1+\pi*}{1+\pi_{t+1}}-1\right]+\left[\frac{(1+\pi*)^2}{(1+\pi_{t+1})(1+\pi_{t+2})}-1\right]+\cdots+\left[\frac{(1+\pi*)^T}{(1+\pi_{t+1})\ldots(1+\pi_{t+T})}-1\right]\right\}$$

Note that a boost to the inflation rates, $\pi_{t+i}>\pi^*$, implies a negative value of ΔB.

As stressed by Cochrane (2001), there is a multiplicity of future inflation rates corresponding to a given reduction in the nominal market value of public debt, ΔB, on the left side of Eq.(8). In particular, if the debt maturity, T, is long, part of the inflation surge can occur in the distant future. Cochrane argues that it may be optimal to smooth out the required boost to inflation rates and that monetary policy can be used to achieve the desired path of inflation, while generating a given value of ΔB in Eq.(8). In the present analysis, we work directly with the time path of inflation rates and not with the changes in monetary instruments, including short-term nominal interest rates, that support this path. That is, we assume that the monetary authority does whatever is necessary to generate the chosen time path of inflation rates (and that these monetary actions do not impact the time paths of real variables). Moreover, we focus on the extreme case of smoothing in which the higher inflation rate, π_{t+i}, is constant at a value $\pi > \pi^*$ for $i=1, \ldots, T$. In that case, Eq.(8) can be shown to simplify to:[4]

(9) $$\Delta B = B_t^0 \cdot \left\{ \left(\frac{1}{\pi - \pi *} \right) \left[1 - \left(\frac{1+\pi *}{1+\pi} \right)^T \right] - T \right\}$$

The expression on the right side includes the maximum debt maturity, T. If we approximate the term $\left(\frac{1+\pi *}{1+\pi} \right)^T$ with a second-order expansion of π around π^*, Eq. (9) simplifies further to:

(10) $$\Delta B = -B_t^0 \cdot \frac{1}{2} T^2 \cdot (\pi - \pi *)$$

Note again that a negative value of ΔB corresponds to a boost in the inflation rate, $\pi > \pi *$. Moreover, as is important later, for a given value of ΔB, larger values of B_t^0 or T associate with smaller values of $\pi - \pi *$.

If the surge in inflation "financed" 100% of the increase in government expenditure, the magnitude of the real value $\Delta B / P_t$, where ΔB is given in Eq.(10), would equal the present value of the increase in real primary deficits from Eq.(4). We can readily generalize to the case where the surge in inflation pays for the fraction η of the spending surge, where $0 \leq \eta \leq 1$, so that the fraction $1-\eta$ is paid for by cuts in spending beyond date $t+M$ or by increases in current or future government revenue. The resulting expression for the rise in the inflation rate, $\pi - \pi^*$, is

(11) $$\pi - \pi * = \eta \cdot \left[\Delta \left(\frac{G_t}{Y_t} \right) + \Delta \left(\frac{G_{t+1}}{Y_{t+1}} \right) + \cdots + \Delta \left(\frac{G_{t+M}}{Y_{t+M}} \right) \right] / \left[\left(\frac{B_t^*}{P_t Y_t} \right) \cdot \left(\frac{T}{2} \right) \right]$$

[4]This result uses the approximation $\pi^* << 1$, which must hold as the length of the period approaches zero.

where we used the expression for B_t^* in Eq.(7).[5] The object *T/2* represents the "average maturity" of the outstanding stock of public debt at the start of period *t*. Note that Eq. (11) implies a non-negative slope coefficient, η ($0 \leq \eta \leq 1$), and an intercept of zero; that is, $\pi = \pi^*$ when the increments to ratios of government spending to GDP add to zero.

The case $\eta = 0$ applies in Eq. (11) when the surge in primary government spending up to date $t+M$ in Eq. (4) is matched by expectations of offsetting cuts in spending further in the future or increases in current and future government revenue. This case can be regarded as standard intertemporal public finance in the sense of the government always respecting the constraint that an increase in today's real primary deficit must be balanced by corresponding reductions in future real primary deficits (all measured as real present values). Therefore, we might expect $\eta = 0$ to hold in most circumstances, with $\eta > 0$ applying only during economic emergencies, such as the COVID crisis or a large war. Hence, the discussion fits with the state-contingent fiscal-deficit policies analyzed by Lucas and Stokey (1983) in the context of wartime, notably World War II.[6] The upshot of this perspective is that fiscal deficits and inflation might not be much related during "normal" economic times but could be closely connected during unusual events.[7] This perspective fits with our empirical application to OECD countries in the context of the COVID crisis.

Equation (11) provides the functional form used in the main empirical work. Note that this form implies, not surprisingly, that the rise in the inflation rate is higher the larger the cumulative rise in G_{t+i}/Y_{t+i} for $i=1, \ldots, M$. Less intuitively, the rise in the inflation rate is larger

[5]The result assumes that *T* measured in numbers of periods is much larger than one.
[6]However, price controls are often important in assessing wartime data.
[7]This result accords with Bassetto and Miller (2023, abstract), who argue "This setting explains why there can be long stretches of time during which government surpluses have large movements with little inflation response; yet, at some point, something snaps, and a sudden inflation takes off that is strongly responsive to fiscal news."

the *smaller* the baseline debt-GDP ratio, B_t^*/P_tY_t. This result follows because a smaller debt-GDP ratio implies that a higher inflation rate is required to get the decline in the real market value of public debt needed to balance the surge in real primary deficits. A higher average debt maturity, $T/2$, also implies a smaller increase in the inflation rate. The reason is that, with the size of the cumulative increase in G/Y held fixed and the inflation rate equalized over T periods, a higher T implies that a smaller inflation rate is required each period to generate the requisite reduction in the real value of public debt. This decrease in the real market value of debt results from revaluation effects generated by increases in expected inflation rates and, correspondingly, nominal interest rates. Overall, the model says that the inflation rate reacts to a composite government-spending variable, which equals the cumulative surge in ratios of government spending to GDP divided by the initial debt-GDP ratio and the average debt maturity.

Given the value of the composite government-spending variable, Eq. (11) says that the deviation of the inflation rate, π, from the fixed π^* depends on the parameter η, which specifies the share of financing from inflation. We think of η as a governmental choice and one that can vary across countries in a given time period.

Another margin of choice that could be introduced concerns the smoothing of inflation rates—these were taken to be equalized over the interval of T years, which likely exceeds the interval M associated with the surge in government spending. Governments could instead choose to react faster or slower in terms of the response of near-term inflation.

In the application of Eq. (11) to cross-country macroeconomic data, we think of adding on an error term that "explains" why the R-squared of the regressions is not one. This residual can arise because of measurement error in the left- and right-side variables, differences in expectations about future government spending or current and future taxes, and variations in the coefficient η, which represent differences in how much of extra government spending is financed via inflation. Some of these variations across countries would reflect governmental choices derived from differences in political structure and in the nature and extent of COVID infections.

In the empirical application of Eq. (11) to inflation rates across OECD countries from 2020 to 2022, the main explanatory variable is the composite government-spending variable. The analysis allows in addition for an effect from the Ukraine-Russia War (in 2022). Countries that share a common border with Ukraine or Russia are found to have substantially higher inflation rates than would otherwise be predicted. From the perspective of Eq. (11), these effects can be viewed as reflecting choices to finance more or less of government expenditure through inflation or to deviate more or less from the smoothing of inflation rates to place more or less weight on short-term inflation.

II. Data

This section contains a description of the variables used in the regressions. The tables below contain more details.

CPI inflation rates

The left side of Eq.(11) requires data on each country's inflation rate over various periods. The analysis calculates inflation rates from information on consumer price indexes (CPI) values, as reported in *OECD.STAT*. The numbers used for 37 OECD countries for the periods 2010-2019 (pre-crisis) and 2020-2022 (crisis) are in Table 1. The analysis considers in part I the headline CPI inflation rate and in part II the core CPI inflation rate, which excludes energy and food.[8]

Government spending

The terms in brackets on the right side of Eq.(11) involve changes in each country's spending levels expressed as ratios to GDP. This variable comes from information for general government on primary expenditure, which includes government purchases and transfer payments but excludes interest payments. These data are from IMF, *World Economic Outlook Data Base, Government Finance Statistics*, and *Article IV Staff Reports*. The *WEO* data is the primary source because its coverage extends to 2022. The calculations use the cumulative annual changes in ratios of government spending to GDP from 2020 to 2022 expressed relative to a base ratio, taken to be the value for 2019 (pre-crisis). These values are in Table 2, column 1. The analogous variable for general government revenue, which we do not use in our main analysis, is in Table 2, column 2.

Quantities of public debt

The right side of Eq. (11) includes in the denominator the ratio of the stock of public debt to GDP in a base year, taken in the empirical analysis to be the end of 2019. The concept of public debt used in the main analysis is the gross debt of general government, coming from the IMF sources (primarily the *WEO* data base). These numbers are mostly at estimated market

[8]This approach does not deal with differences across countries in CPI construction outside of energy and food. For example, countries differ in their treatment of housing costs, notably in the inclusion or exclusion of implicit rentals on owner-occupied housing.

value but sometimes are at face value. Ratios of gross public debt to GDP for general government in 2019 are in Table 2, column 3.

An alternative procedure adjusts the gross public debt for amounts denominated in foreign currency or in inflation-indexed form. These parts of the debt would not be subject to direct reductions in real value due to effects of domestic inflation on domestic nominal interest rates for given real interest rates. Since we are neglecting any changes in real interest rates, it may be appropriate to filter out these parts of the gross public debt. However, measurement issues may make the unadjusted data preferable, and our main analysis uses the unadjusted gross public debt.

The estimated shares of public debt denominated in foreign currency or in inflation-indexed form come mostly from Bank for International Settlements (BIS), *Central and General Government Debt Securities Markets*, Tables C4 and C2. These values are in Table 3, columns 3 and 4. The numbers for debt denominated in foreign currency apply to general government. The numbers for debt in inflation-indexed form apply to central government. We adjusted these numbers by ratios of central to general government expenditure (from the IMF's *GFS* data base) to estimate the values applicable to general government (assuming that only central governments issue inflation-indexed bonds). The ratios to GDP of adjusted gross public debt—with amounts denominated in foreign currency or in inflation-indexed form filtered out—are in Table 2, column 4.[9]

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[9]It may also be desirable to adjust for public debt issued in floating-rate form. Since these coupon payments adjust automatically for changes in expected inflation (given the values of real interest rates), the corresponding part of the value of outstanding bonds should be filtered out in the calculation of adjusted public debt. However, we have data (from the BIS) on the floating-rate share of gross public debt only for central governments and only for 14 countries. The average share of government bonds in floating-rate form for these countries in 2022 is only 9%, and only the coupon parts of the values of these bonds should be filtered out. Therefore, the neglect of an adjustment for floating-rate bonds may not have major consequences.

In principle, we would carry out the analysis for the consolidated government sector. The IMF's concept of general government, described in International Monetary Fund (2014, Chapter 2), includes various layers of government (central, state, local, etc.) along with social security funds. This concept excludes public corporations, which include central banks. (The IMF includes public corporations in a broader measure called the public sector.) The consolidation of central banks with general government would be desirable for the purposes of studying inflation. In this broader consolidation, the debts of central banks, including reserves held by financial institutions and others, would be added to the gross public debt. However, in a net calculation, the assets held by central banks would be deducted.[10] If the assets and debts of central banks largely cancel, this broader consolidation would not have much impact on a net concept of public debt but would likely lower the average maturity of the debt—because central bank liabilities tend to be shorter term than central bank assets. In any event, data are not available for this broader consolidation.

The IMF also provides information on "net debt," which subtracts out holdings by general government of assets comparable to government bonds (see IMF [2014, pp. 207-208]). However, the net-debt measures (shown in Table 2, column 5) were not used because they filter out unknown quantities of assets denominated in foreign currency.[11] As extreme examples, using the IMF reported data for 2019 shown in Table 2, columns 3 and 5, the ratios to GDP of gross

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[10]As an example, the gross public debt of Japan is the largest in relation to GDP—260% in 2022, but slightly over half of this debt in 2023 is held by the central bank (as reported by *Japan Times*, May 2023). In addition, unlike other countries, Japan's gross debt for general government is reported without the consolidation of social-insurance funds.

[11]For example, sovereign wealth funds hold large amounts of U.S. Treasury bonds. Using *Wikipedia* for data for 2020 on the U.S. dollar value of sovereign-wealth funds, the largest of these funds among the OECD countries when measured in relation to the U.S. dollar value of GDP (taken from World Bank, *World Development Indicators*) are for Norway (237% of GDP), France (51%), Turkey (31%), Canada (16%), New Zealand (15%), South Korea (12%), Australia (8%), Austria (8%), and Chile (8%). The parts of sovereign-wealth holdings denominated in foreign currency should not be netted out from gross public debt for the purpose of analyzing inflation.

and net public debt are, respectively, 41% and -74% for Norway, 90% and 8% for Canada, 236% and 152% for Japan, 32% and 7% for New Zealand, 35% and 5% for Sweden, 65% and 27% for Finland, and 22% and -14% for Luxembourg. Although netting out asset holdings by various parts of government is attractive in principle, we think at this point that the data on gross public debt are better for our purposes than the data on net public debt.

Duration of public debt

We began with data from the OECD on a standard measure, the "average remaining maturity" of the public debt, a concept that considers only the timing of the principal payouts due on each bond. The values for general government of average remaining debt maturity in 2019 (coming mostly from OECD, *Sovereign Outlook for OECD Countries, Survey on Central Government Marketable Debt and Borrowing*) are in Table 3, column 1.

A more appropriate concept is the duration of a bond, which considers also the amounts and timings of coupon payments. We define the duration in the usual (Macaulay [1938, Chapter II]) sense as the weighted average of due dates for each coupon and principal payout, where the weights are the market values corresponding to each payout expressed relative to the total market value of bonds. Although the duration of the public debt can be calculated from detailed knowledge of all government bonds outstanding at a given point in time, this calculation is challenging for the set of 37 OECD countries used in the empirical analysis. We have also found little in direct reporting on the duration of the public debt.[12] Therefore, it is useful to be able to approximate the debt duration given the typically available data, which

[12]In the past, *OECD.STAT*, *Central Government Debt, Average Term to Maturity and Duration,* reported the Macaulay duration or, alternatively, the modified duration of the central government's debt for many OECD countries (although some of the reported numbers for duration appear to be inaccurate). In any event, the relevant table was terminated as of 2010.

include the average remaining maturity based only on principal payments and the nominal interest rates paid on government bonds.

The Appendix derives a formula for the duration of a standard bond that pays a constant stream of nominal coupons and a nominal principal in year T. We assume for date t (taken to be 2019 in the empirical analysis) that bonds were "trading at par" in the past when the nominal interest rate was R_{t-L} (measured empirically by averages of long-term nominal interest rates on government bonds going back from 2018 the number of years corresponding to the estimated duration). At date t (2019), the nominal interest rate on government bonds is observed to be R_t, which can differ from R_{t-L}.[13] For this case, the formula in the Appendix relates the duration, D_t, to the reported average maturity and to the interest rates R_t and R_{t-L}. The resulting estimates of the duration of the public debt in 2019 are in Table 3, column 2.

It would be desirable to estimate the duration applying only to the public debt denominated in domestic currency and not indexed for inflation. However, we lack the breakdown of debt maturity needed to make that calculation.

Euro-area data

In our main specification, we consider the Euro area as a single economic entity. There are 17 OECD countries that use the Euro.[14] Except for duration and some other debt-related variables (average debt maturity and shares of gross public debt denominated in foreign currency or in inflation-linked form), we weight all country-level variables by the relative values of GDP

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[13]The data on interest rates on long-term government bonds for 37 OECD countries are from *OECD.Stat* and IMF, *International Financial Statistics.* Data for Costa Rica are for 2014-2019. Data for Estonia begin in 2015 and are approximated by 6-month Euribor interest rates reported by the Central Bank of Estonia.

[14]The countries are Austria, Belgium, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Portugal, Slovakia, Slovenia, and Spain. Three non-OECD countries also use the Euro: Malta, Croatia (which joined the OECD in 2023), and Cyprus.

in current prices from the IMF. For duration and the other debt-related variables, we weight by the size of outstanding gross public debt (using the IMF data on the ratio of gross debt to GDP, along with the GDP weight).

Proximity to war in Ukraine

We constructed measures for 37 OECD countries on distance to Ukraine and Russia, based on country capitals and on an array of major cities. We also constructed shares of each country's trade with Ukraine and Russia. However, we found in the analysis of inflation rates that the main explanatory power came from a simple dummy variable for whether a country had a common border with Ukraine or Russia (of which 3 had a border with Ukraine and 6 had one with Russia, with Poland having a border with both). Our analysis focuses on this border dummy variable.

III. Empirical Results

A. Identification

In a general sense, we seek to isolate effects on inflation rates from exogenous movements in government spending. An ideal setting would be a controlled experiment whereby governments in various countries randomly set levels of real spending—or ratios of spending to GDP—at sharply differing values. Of course, these kinds of large-scale, vastly expensive experiments will never be carried out, as is true in most macroeconomic contexts. So, instead, our econometric procedure uses the available macroeconomic data for a cross-section of countries to attempt to isolate effects on inflation rates from movements in government spending. That is, we rely on "old-style econometrics."

More concretely, in the context of the COVID-related recession and recovery, the cross-country regressions seek to isolate effects on inflation rates from 2020 to 2022 from movements in government spending over the same period. This analysis is helped by the use of a particular functional form—shown in Eq.(11)—that the fiscal theory of the price level says should matter for inflation. Specifically, the composite government-spending variable on the right side of Eq. (11) factors in cumulative increases in ratios of general government spending (exclusive of interest payments) to GDP from 2020 to 2022 gauged relative to the ratio for 2019, divided by the debt-GDP ratio in 2019 and by the debt duration in 2019. The property needed for identification is that the cross-country variations in this composite government-spending variable are exogenous with respect to inflation. For example, it might be that government-spending decisions after 2019, particularly on transfer payments, depended on exogenous differences in political structure or in the perceived severity of COVID infections.

One concern is that the cumulative increases in ratios of general government spending to GDP from 2020 to 2022 responded positively to the size of the economic downturn, which is concentrated for most countries in the negative growth rate of real GDP from 2019 to 2020. The average of this growth rate for the 37 OECD countries used in this study is -4.2%. The interaction of the increases in government spending with the extent of the decline in real GDP may then also imply interactions with inflation.

An OLS regression that illustrates the connection between changes in government spending and the extent of the economic downturn for the 37 OECD countries in the sample is:

$$(12) \quad \Delta(G/Y)\ (2020\text{-}2022) = \underset{(0.03)}{0.05} - \underset{(0.33)}{1.14}{*}\Delta Y\ (2019\text{-}2020) + \underset{(10.4)}{11.3}{*}COVID$$

$$\text{R-squared}=0.34,\ \sigma=0.069,$$

where standard errors of estimated coefficients are in parentheses, *Δ(G/Y)* is the cumulative increase in the ratio of general government primary spending to GDP from 2020 to 2022 expressed relative to the ratio for 2019, *ΔY* is the growth rate of real GDP from 2019 to 2020, and *COVID* is cumulative COVID-related mortality per capita up to July 2023.[15] The estimated coefficient on the growth rate of real GDP is negative and highly statistically significant, indicating that countries with larger downturns reacted with more government spending. The estimated coefficient on the *COVID* variable is positive but not significantly different from zero. (We had hoped to use the *COVID* variable as an instrument for government spending, but the weak empirical connection between these two variables precludes this procedure.)

The issue for our empirical analysis is whether the tendency for the surge in government expenditure to be larger when the economic downturn is more severe would tend to generate a spurious positive association between government spending and inflation. To get this result, we would have to see a larger economic downturn typically followed by *higher* inflation. However, this relationship conflicts with the usual empirical pattern whereby the association between real economic activity and inflation at business-cycle frequencies tends to be positive.[16]

If we change the dependent variable in Eq. (12) to be the composite government-spending variable dictated by the fiscal theory of the price level, then the regression for the 37 countries becomes:

$$\text{(13)} \quad \text{government-spending variable} = \underset{(0.014)}{0.023} + \underset{(0.17)}{0.07}{*}\Delta Y\ (2019\text{-}2020) + \underset{(5.3)}{7.1}{*}COVID$$

$$\text{R-squared}=0.05,\ \sigma=0.035,$$

[15]The data on COVID-related mortality are from the World Health Organization, *WHO Coronavirus (COVID-19) Dashboard* . Results are similar if the COVID outcomes are cumulated only up to December 2021. The data on real GDP are from World Bank, *World Development Indicators*.

[16]See Bianchi, Nicolo, and Song (2023) and Justiniano, Primiceri, and Tambalotti (2013) for discussions of the relation between inflation and real economic activity over the business cycle.

where the dependent variable is *Δ(G/Y)* from Eq. (12) divided by the ratio of gross public debt to GDP in 2019 and by the duration of the debt in 2019. The other variables are the same as in Eq. (12). In contrast to Eq. (12), the estimated coefficient on the growth rate of real GDP in Eq. (13) does not differ significantly from zero, and the R-squared value is close to zero. The main reason for the differing results is that the initial debt-GDP ratio (for 2019) has a substantial negative association with the growth rate of real GDP from 2019 to 2020.[17] Since the debt-GDP ratio enters inversely into the composite government-spending variable, this negative association offsets the negative relation between the growth rate of real GDP and *Δ(G/Y)* shown in Eq. (12). Because this offset is nearly complete, the connection between the growth rate of real GDP and the composite government-spending variable in Eq. (13) turns out to be negligible. This finding lessens the concern that endogeneity in the government-spending variable would lead to a spurious positive association between this variable and inflation. Accordingly, we treat the composite government-spending variable as exogenous in the cross-country OLS regressions for inflation rates reported below. We are hoping to go further by using appropriate instruments for the composite government-spending variable, possibly involving differences in political structure across the OECD countries.

We have constructed comparable variables for the revenue side of the government, including the variable *Δ(REV/Y)* (Table 2, column 2) and the corresponding composite government-revenue variable. However, we are not confident that this composite revenue variable can be treated as exogenous with respect to inflation. Moreover, from 2020 to 2022, the changes in the spending variable, *Δ(G/Y)*, dominate the changes in the corresponding revenue

[17] Possibly this pattern arises because the outstanding debt is a good proxy for the fiscal capacity of a country. Specifically, countries with larger ratios of public debt to GDP may be more economically fragile and, therefore, less able to deal effectively with crises such as the one associated with the COVID pandemic.

variable, *Δ(REV/Y)*—the means and standard deviations for 2020-2022 are, respectively, 0.122 and 0.082 compared with 0.016 and 0.037 (see Table 4 below). Therefore, the spending side of the surge in real primary deficits likely captures the principal fiscal influence on inflation rates in this period. For this reason and because of concerns about endogeneity of the composite government-revenue variable, we limit the main regressions below to effects from government spending.

The identification in our analysis comes from cross-sectional variation across OECD countries in inflation rates (for 2020-2022 relative to those for 2010-2019) and in composite government-spending variables (cumulations of ratios to GDP for 2020-2022 compared to the ratio in 2019). The form of the estimation precludes the common practice of including country fixed effects as regressors, because this procedure would eliminate the cross-sectional variation needed to estimate the coefficients. The OLS regressions that we use also assume that the error terms in the equation for inflation are independent across countries. A correction for spatial correlation of error terms might improve the calculation of standard errors but our setup with only one time-series observation for each country provides no way of assessing this spatial correlation.

B. Regressions

The sample comprises 37 OECD countries, 20 outside of the Euro zone and 17 in this zone. Within the Euro zone, the constraint of a common currency may preclude much independent variation in inflation rates, which would have to represent changes in relative prices across these countries. Therefore, we start with a setting in which the 17 Euro-zone countries are combined (through weighted averages involving GDP and other variables) into single aggregate observations. That is, the initial regression sample consists of 21 economies; 20 countries outside of the Euro zone along with an aggregated version of the Euro zone.

Table 4 shows means, standard deviations, and maximum and minimum values for the variables used in the regressions. Table 5 reports OLS regressions for changes in CPI inflation rates—gauged by average rates over the crisis years 2020-2022 considered relative to average rates over the pre-crisis, ten-year period 2010-2019. Columns 1 and 2 consider headline CPI inflation, and columns 3 and 4 consider core CPI inflation, computed without energy and food.

Columns 1 and 3 of Table 5 use as explanatory variables only constant terms and the composite government-spending variable.[18] The estimated coefficients of the government-spending variable are positive and highly statistically significant: 0.37 (s.e.=0.10) for headline inflation in column 1 and 0.42 (0.09) for core inflation in column 3.

Because the dummy variable for whether a country shares a common border with Ukraine or Russia has substantial explanatory power for inflation, our discussion emphasizes the results that include this border dummy variable, as shown in Table 5, columns 2 and 4.[19] Eight of the 37 OECD countries in the full sample share a common border with Ukraine or Russia but only three of these are outside of the Euro zone: Hungary, Norway, and Poland. The estimated coefficients on the border dummy, 0.028 (s.e.=0.005) for headline inflation in column 2 and 0.022 (0.005) for core inflation in column 4, are positive and highly statistically significant.[20]

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[18]The regressions in Table 5 use unadjusted gross public debt in the construction of the composite government-spending variable. Results, shown in Appendix Table A1, that adjust the debt to eliminate the parts denominated in foreign currency or in inflation-indexed form are broadly similar. The fits of the regressions also change negligibly if the reported average debt maturity (Table 3, column 1) is used instead of the estimated duration (Table 3, column 2). This finding is not surprising because the correlation in 2019 between the average debt maturity and the estimated duration is 0.95.

[19]OECD countries having a common border with Ukraine are Hungary, Poland, and Slovak Republic. Those sharing a border with Russia are Estonia, Finland, Latvia, Lithuania, Norway, and Poland.

[20]Results for the government-spending variable are similar if, instead of entering the border dummy variable, the economies that border Ukraine or Russia are excluded from the sample. For 17 economies, the regression for headline inflation becomes 0.0078 (0.0032) + 0.427 (0.090)*govt-spending variable, R-squared = 0.599, σ=0.0086,

The inclusion of the border dummy variable raises the estimated coefficients of the composite government-spending variable. Specifically, the estimated coefficients on the composite government-spending variable are now 0.42 (s.e.=0.06) for headline inflation in column 2 and 0.46 (0.06) for core inflation in column 4.[21]

Although the estimated effects of the composite government-spending variable on the changes in the inflation rates in Table 5 are significantly positive, they are also significantly different from one, which is the coefficient η that applies in Eq. (11) when all of the excess government spending from 2020 to 2022 is "paid for" by the inverse effect of inflation on the real market value of the initial public debt. A more realistic scenario is that part of the added spending is expected to be financed by the more conventional method of eventually cutting real primary deficits; that is, by reducing government spending from 2023 onward or by raising government revenue from 2020 onward. A coefficient of 0.4-0.5 (as in Table 5, column 2 and 4) suggests that 40-50% of the required financing comes from the negative effect of inflation on the real market value of the public debt, whereas the remaining 50-60% comes from more standard methods of intertemporal public finance.

The cross-country relationships between the dependent variable in Table 5 (the change in the headline or core CPI inflation rate) and the composite government-spending variable are depicted for headline inflation in Figure 1 and core inflation in Figure 2.[22] Each country is marked by its standard acronym. Note that the points for the United States are not outliers—they

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and that for core inflation becomes -0.0030 (0.0028) + 0.568 (0.079)*govt-spending variable, R-squared = .775, σ=.0075.

[21]We have added the composite-revenue variable (excess revenue from Table 2, column 2, divided by the gross public debt from Table 2, column 3 and by the estimated duration from Table 3, column 2) to the regressions for headline and core inflation in Table 5, columns 2 and 4, respectively. The estimated coefficients of this variable are -0.21 (s.e.=0.15) for headline inflation and -0.03 (0.16) for core inflation. The estimated coefficients of the other variables change little from those shown in Table 5, columns 2 and 4..

[22]In the figures, the estimated relationships with the border dummy variable are filtered out from the government-spending variable and the changes in the inflation rates.

lie slightly above the middle of the sample with respect to the government-spending variable and the change in the headline or core inflation rate. The points for the Euro area are below those for the United States with respect to the inflation rates and slightly below with respect to the government-spending variable. Overall, the figures show clear positive slopes that do not seem to be driven by extreme observations.

The regressions include the composite government-spending variable, which equals $\Delta(G/Y)$, the cumulation from 2020 to 2022 of ratios of general government spending to GDP gauged relative to ratios for 2019, divided by the ratio of gross public debt to GDP in 2019 and by the debt duration in 2019. As already noted, the estimated coefficients of this composite spending variable are positive and highly statistically significant.

We can assess how the statistical significance of the composite government-spending variable relates to the contributions from its three individual components; $\Delta(G/Y)$, the debt-GDP ratio, and the debt duration. We focus on the cases from Table 5, columns 2 and 4, which include the border dummy for Ukraine or Russia. Table 6 reports corresponding regressions in which each component of the composite government-spending variable is set, one at a time, at its sample mean. That is, in these models, the designated variable is restricted not to contribute to the explanation of the cross-sectional variations in inflation rates. For example, in column 1, $\Delta(G/Y)$ for each country is constrained to equal the sample mean of 0.101 and, therefore, no longer helps to explain the cross-sectional variations in the change in the headline CPI inflation rate. Note that, in comparison with Table 5, column 1, the R-squared falls dramatically, from 0.791 to 0.319, and the log(likelihood) falls by 12.4.

In one approach, we think of constraining each variable to equal its sample mean as amounting to one coefficient restriction imposed on the estimation. Then we test for the validity of this restriction by using the condition that -2*log(likelihood ratio) is distributed asymptotically as a Chi-squared variable with one degree of freedom. For example, in Table 6, column 1, the resulting p-value for $\Delta(G/Y)$ is 0.000. This result also applies for core inflation (column 4). Hence, $\Delta(G/Y)$ is individually statistically significant for explaining headline and core inflation rates.

The same conclusion applies to the initial ratio of gross public debt to GDP. The p-values associated with this variable are 0.000 for headline and core inflation (Table 6, columns 2 and 5). Therefore, the initial debt-GDP ratio is individually statistically significant for explaining inflation rates.

The initial duration of the public debt is statistically significant with p-values of 0.007 for headline inflation (Table 6, column 3) and 0.025 for core inflation (column 6). Therefore, the initial debt duration is individually statistically significant for explaining inflation rates.

An issue with this approach is that the model in which all three components of the composite government-spending variable enter (Table 5, columns 2 or 4) and the models where one of the components is restricted to equal its sample mean (Table 6, columns 1-3 or 4-6) are not nested. In fact, it is possible that imposing the condition that a variable enter only at its sample-mean value would raise the likelihood, although that outcome does not materialize in our cases. As an alternative, we compare the models using the Akaike information criterion (*AIC*), which amounts to another procedure for assessing the likelihood ratios for the various models.[23] According to the *AIC*, for both headline and core inflation, the weight attached to the restricted

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[23]The *AIC* equals $2k\text{-}2\cdot log(\mathcal{L})$, where k is the number of free parameters and $\mathcal{L}$ is the likelihood. In our case, *k* is the same for all of the alternative models and does not affect the calculations. The models can be compared using the relative likelihood, $RL=exp[(AIC_1\text{-}AIC_2)/2]$, where AIC_1 is the value from Table 5, columns 2 or 4, and AIC_2 is the value from Table 6, columns 1-3 or 4-6. The weights on the two models are then $1/(1+RL)$ and $RL/(1+RL)$. See, for example, Burnham and Anderson (2002, Section 2.2).

models is 0.000 for *Δ(G/Y)* and the debt-GDP ratio. For debt duration, the weight on the restricted model is 0.027 for headline inflation and 0.074 for core inflation. Thus, overall, the conclusions are similar to those found before—there is strong support for the model in which the composite government-spending variable combines influences from *Δ(G/Y)*, the initial debt-GDP ratio, and the initial debt duration.

We interpret the border dummy variable in the regressions as a proxy for effects on inflation from the Ukraine-Russia War. Since the estimated coefficient for core inflation (Table 5, column 4) is almost as large as that for headline inflation (column 2), this border effect does not work primarily through energy prices but likely involves supply chains more broadly.[24] If we consider inflation rates and the composite government-spending variable only through 2021—before the start of the Ukraine-Russia War in 2022—we get estimated coefficients for headline inflation of 0.445 (s.e.=0.081) on the composite government-spending variable and 0.0103 (0.0039) on the border dummy. For core inflation, the estimated coefficients are 0.596 (0.099) on the spending variable and 0.0084 (0.0044) on the border dummy. Therefore, the estimated coefficients for the spending variable are similar to those estimated using data through 2022 (Table 5, columns 2 and 4). The estimated coefficients for the border dummy are about one-third the size of those estimated through 2022, with the estimated coefficient for headline inflation still significantly different from zero and that for core inflation not significantly different from zero at the 5% critical value. Therefore, although the main effect of the border dummy on inflation applies when the data go through 2022, some of the inflation in the border countries before 2022 may reflect forces that do not involve wartime operations.

[24] However, Minton and Wheaton (2022) show that oil-price changes impact an array of other price changes through network effects. Therefore, effects from energy-price changes would show up in core inflation.

The dependent variable in the regressions is the change in the annual inflation rate from the baseline period, 2010-2019, to the sample period, 2020-2022. The underlying assumption in the model is that the high inflation rate starting in 2020 and extending out a period corresponding to the duration of the public debt is fully smoothed out, so that the inflation rate from 2020 to 2022 and additional years beyond would be constant. What matters for the effective revenue generated from inflation beginning in 2020 is the cumulative surge in the price level. In this broader sense, the model is not contradicted by the observation that inflation rates were not constant from 2020 to 2022. For headline CPI, the average annual inflation rate for the 21 economies was 1.9% in 2019, 1.4% in 2020, 3.1% in 2021, 8.2% in 2022, and 5.5% for the third quarter of 2023. The corresponding values for core CPI inflation were 1.9%, 1.7%, 2.4%, 5.7%, and 5.7%. Therefore, the empirical pattern—which does not contradict the main implications of the theory—is that inflation built up gradually and eventually leveled off and started to fall.[25]

In Table 5, the dependent variable is the average headline or core inflation rate for 2020-2022 less that for 2010-2019. We can use instead the inflation rate for 2020-2022 as the dependent variable and add the inflation rate for 2010-2019 as an independent variable with a free coefficient. In this form, the estimated coefficient of the inflation rate for 2010-2019 turns out to be 1.21 (s.e.=0.17) in the regression for headline inflation, corresponding to Table 5, column 2, and 0.97 (0.18) in the regression for core inflation, corresponding to column 4. That is, the results support the hypothesis that a country's inflation rate from 2020 to 2022 responds with a unit coefficient to its trend or long-run inflation rate, gauged by the average inflation rate for the ten years from 2010 to 2019.

[25]However, less easy to explain is the pattern in long-term nominal interest rates on government bonds. The theory says that, with real interest rates fixed, these nominal rates should have risen quickly in 2020. In fact, the average of these rates for the 21 economies was 2.4% in 2019, 1.4% in 2020, 2.0% in 2021, 3.9% in 2022, and 4.3% in the second quarter of 2023.

We checked whether the connections between the inflation rate and the composite government-spending variable depended on the extent of the COVID-related economic downturn, measured as before by the growth rate of real GDP from 2019 to 2020. If we enter this growth rate into the regressions in Table 5, we find for headline inflation (column 2) that the estimated coefficient on the real GDP growth rate does not differ significantly different from zero, -0.057 (s.e.=0.060), and the estimated coefficients and standard errors for the other variables are virtually unchanged. Similarly, for core inflation (column 4), the estimated coefficient on the real GDP growth rate is -0.033 (s.e.=0.060), and the estimated coefficients and standard errors for the other variables are again virtually unchanged. These results suggest that the estimated effects of the composite government-spending variable on inflation rates in Table 5 do not involve a proxying for general economic conditions, in the sense of the size of the economic downturn in 2019-2020.

We now compare the results with the Euro zone treated as a single economy to those with each Euro-zone country considered individually. Table 7 shows regressions for 37 countries—20 non-Euro and 17 Euro. As in Table 5, the first government-spending variable equals excess government spending divided by gross debt and duration. For the Euro countries, this variable takes on a single value, equal to the weighted average of the government-spending variable for these countries. The regressions also include a second government-spending variable for the Euro countries—the difference between the individual value and the weighted-average value. A coefficient of zero on this second variable means that inflation in a Euro-zone country depends on government spending only through the weighted-average value, not the individual value. A coefficient on the second variable equal to that on the first variable means that inflation in each

Euro country depends on that country's own spending, in the same way as for each non-Euro country.

When the border-dummy variable is included in columns 2 and 4 of Table 7, the estimated coefficients of the individual government-spending variables for the Euro countries do not differ significantly from zero at the 5% level.[26] These results mean that inflation in these countries responds mainly to the Euro-wide average of the government-spending variable, rather than to the country's own spending. In this sense, the results accord with those in Table 5, which used the same government-spending variable for each Euro-zone country.[27]

The cross-country relationships between the dependent variable in Table 7 (the change in the headline or core CPI inflation rate) and the composite government-spending variable are depicted for headline inflation in Figure 3 and core inflation in Figure 4. In comparison with Figures 1 and 2, the difference is that the Euro-zone countries are entered with their individual government-spending variables, rather than as a Euro-area weighted average. Figures 3 and 4 separate out the relationship within the Euro area (17 countries) from that outside this area (20 countries). As already suggested from Table 7, the slopes of the relationship between the changes in the inflation rates and the government-spending variable are clearly positive within the non-Euro zone but much flatter within the Euro zone. For core inflation, this slope is essentially zero in the Euro zone.

[26] Results are again similar if, instead of including the border dummy in the regressions, the countries that border Ukraine or Russia are excluded from the sample. For 29 economies, the regression for headline inflation is then .0092 (.0025) + .428 (.076)*govt-spending variable -.067 (.198)*govt-spending variable for Euro area, R-squared = .552, σ=.0072 and that for core inflation becomes -.0041 (.0022) + .567 (.068)*govt-spending variable - .057 (.179)*govt-spending variable for Euro area, R-squared = .726, σ=.0065.

[27] The results in Table 7 estimate a single coefficient on the border dummy for non-Euro and Euro countries. The hypothesis of equal coefficients in the two areas is accepted at the 5% level. This result suggests that, although differences in the government-spending variable do not significantly affect relative prices across the Euro countries, differences in the border dummy do have these relative-price effects (at least temporarily). The constant term in Table 7 is also the same for the non-Euro and Euro countries. The hypothesis of equal constant terms is accepted at the 5% level.

IV. Conclusions

In response to the COVID pandemic, many countries implemented large increases in deficit-financed government spending from 2020 to 2022. To the extent that these fiscal interventions were perceived as not backed by current and future tax increases or future spending cuts, the fiscal theory of the price level, FTPL, predicts that countries should experience a rise in their inflation rates. In a simple setting that neglects effects on inflation from changes in real variables, the predicted increases in inflation rates are proportional to the size of the fiscal stimulus, measured by the cumulative increases in ratios of spending to GDP. However, for a given fiscal stimulus, a country's surge in inflation should be lower if it starts with a larger ratio of public debt to GDP or has a longer duration of this debt.

We find support for these theoretical predictions of the FTPL. Specifically, we show for a sample of 21 economies—20 non-Euro-zone OECD countries and an aggregated version of 17 Euro-zone countries—that headline and core inflation rates in 2020-2022 responded positively to a theory-motivated government-spending variable. This variable includes cumulated increases in spending-GDP ratios divided by the pre-pandemic level of the debt-to-GDP ratio and by the average duration of the outstanding debt. In contrast, across 17 Euro-zone countries, differences in the government-spending variable do not generate significant differences in inflation rates. We also find in the sample of 21 economies that, while positive and statistically significant, the coefficient that gauges the response of the inflation rate to the scaled measure of government spending is significantly less than one, the value predicted when all of the extra spending is "paid for" through surprise inflation. The point estimates of coefficients of 0.4-0.5 suggest that 40-50% of the extra spending was financed through inflation, whereas the remaining 50-60%

was paid for through the more conventional method of intertemporal public finance that involves increases in current or prospective government revenue or cuts in prospective future spending.

Our empirical analysis of inflation is based on a model that neglects effects on real variables, such as real GDP, real interest rates, and real exchange rates. In this sense, our framework deviates from many existing theoretical models related to the FTPL. A natural extension would be to allow for effects on real variables. Such an extension might improve the explanation for cross-country variations in inflation rates and also provide understanding of how spending surges and the resulting inflation impact variables such as real GDP, real interest rates, and real exchange rates.

Table 1 Inflation Variables for 37 OECD Countries (Turkey excluded)*

Part I: Headline Consumer Price Indexes

Country	(1) Change in inflation rate	(2) Inflation rate 2010-19	(3) Inflation rate 2020-22	(4) Fitted inflation rate 2020-22
Australia	.0132	.0212	.0344	.0400
Canada	.0190	.0174	.0364	.0404
Chile	.0345	.0296	.0640	.0537
Colombia	.0167	.0373	.0540	.0475
Costa Rica	.0042	.0315	.0357	.0309
Czech Republic	.0568	.0169	.0737	.0617
Denmark	.0210	.0122	.0332	.0282
Hungary	.0520	.0248	.0768	.0776
Iceland	.0207	.0313	.0520	.0630
Israel	.0070	.0107	.0176	.0260
Japan	.0028	.0047	.0075	.0166
Korea, South	.0099	.0172	.0271	.0379
Mexico	.0170	.0396	.0566	.0548
New Zealand	.0270	.0158	.0428	.0462
Norway	.0140	.0211	.0351	.0347
Poland	.0601	.0159	.0760	.0758
Sweden	.0255	.0113	.0368	.0239
Switzerland	.0087	.0003	.0090	.0188
United Kingdom	.0173	.0207	.0380	.0375
United States	.0287	.0177	.0464	.0401
Euro zone (weighted avg)	.0230	.0131	.0361	.0339
Mean	**.0228**	**.0195**	**.0423**	**.0423**
Euro-zone countries:				
Austria	.0237	.0186	.0423	--
Belgium	.0244	.0182	.0426	--
Estonia	.0553	.0233	.0787	--
Finland	.0297	.0127	.0425	--
France	.0206	.0124	.0330	--
Germany	.0203	.0133	.0336	--
Greece	.0253	.0067	.0321	--
Ireland	.0273	.0055	.0328	--
Italy	.0214	.0117	.0331	--
Latvia	.0546	.0147	.0693	--
Lithuania	.0670	.0183	.0853	--
Luxembourg	.0158	.0165	.0323	--
Netherlands	.0303	.0162	.0465	--
Portugal	.0187	.0116	.0303	--
Slovak Republic	.0441	.0155	.0595	--
Slovenia	.0233	.0124	.0357	--
Spain	.0249	.0123	.0372	--
Mean Euro zone	**.0310**	**.0141**	**.0451**	**--**

Part II: Core Consumer Price Indexes

	(5)	(6)	(7)	(8)
Country	**Change in inflation rate**	**Inflation rate 2010-19**	**Inflation rate 2020-22**	**Fitted inflation rate 2020-22**
Australia	.0031	.0199	.0230	.0313
Canada	.0121	.0169	.0290	.0329
Chile	.0260	.0243	.0503	.0415
Colombia	.0000	.0360	.0360	.0379
Costa Rica	-.0123	.0336	.0213	.0236
Czech Republic	.0568	.0125	.0693	.0525
Denmark	.0088	.0119	.0207	.0202
Hungary	.0338	.0262	.0600	.0665
Iceland	.0195	.0308	.0503	.0565
Israel	.0070	.0103	.0173	.0179
Japan	-.0025	.0015	-.0010	.0053
Korea, South	.0011	.0169	.0180	.0304
Mexico	.0109	.0328	.0437	.0402
New Zealand	.0246	.0151	.0400	.0393
Norway	.0067	.0200	.0267	.0172
Poland	.0455	.0115	.0570	.0597
Sweden	.0186	.0091	.0277	.0138
Switzerland	.0066	-.0006	.0060	.0105
United Kingdom	.0113	.0192	.0303	.0284
United States	.0199	.0184	.0383	.0337
Euro zone (weighted avg)	.0090	.0111	.0201	.0243
Mean	**.0146**	**.0180**	**.0326**	**.0326**
Euro-zone countries:				
Austria	.0129	.0188	.0317	--
Belgium	.0094	.0163	.0257	--
Estonia	.0251	.0169	.0420	--
Finland	.0092	.0118	.0210	--
France	.0073	.0084	.0157	--
Germany	.0096	.0121	.0217	--
Greece	.0048	.0019	.0067	--
Ireland	.0162	.0061	.0223	--
Italy	.0036	.0104	.0140	--
Latvia	.0250	.0090	.0340	--
Lithuania	.0387	.0176	.0563	--
Luxembourg	.0068	.0162	.0230	--
Netherlands	.0114	.0159	.0273	--
Portugal	.0120	.0093	.0213	--
Slovak Republic	.0390	.0143	.0533	--
Slovenia	.0177	.0076	.0253	--
Spain	.0078	.0085	.0163	--
Mean Euro zone	**.0151**	**.0118**	**.0269**	**--**

Note: Inflation rates are averages over periods indicated, based on changes in annual averages of CPI values. Data are from *OECD.STAT*. Change in inflation rate in columns 1 and 5 is value for 2020-2022 less that for 2010-2019. The fitted headline CPI inflation rate 2020-2022 in column 4 is from the regression in Table 5, column 2. The fitted core CPI inflation rate 2020-2022 in column 8 is from the regression in Table 5, column 4. Observations for the Euro zone are weighted averages of data for the 17 individual countries.

*Turkey was omitted because of missing data and also because its extreme inflation rate in 2022—72% for headline CPI inflation and 59% for core CPI inflation—is unlikely to be well explained by the fiscal model. Countries currently under consideration for accession to the OECD include Argentina, Brazil, Bulgaria, Croatia, Indonesia, Peru, Romania, and Ukraine.

Table 2 Fiscal Variables Based on IMF Data for General Government
37 OECD Countries (Turkey excluded)

	(1)	(2)	(3)	(4)	(5)
Country	**Excess Govt Spending relative to GDP cum. 2020-22**	**Excess Govt Revenue relative to GDP cum. 2020-22**	**Gross debt relative to GDP 2019**	**Adjusted gross debt relative to GDP 2019**	**Net debt relative to GDP 2019**
Australia	.082	.030	.467	.444	.279
Canada	.188	.023	.902	.772	.085
Chile	.096	.046	.283	.125	.080
Colombia	.017	-.068	.524	.310	.431
Costa Rica	-.052	.013	.564	.322	.453
Czech Republic	.152	.001	.300	.266	.181
Denmark	.048	-.015	.337	.324	.123
Hungary	.110	-.034	.653	.485	.584
Iceland	.173	-.009	.666	.359	.544
Israel	.060	.038	.588	.296	.575
Japan	.198	.055	2.364	2.358	1.517
Korea, South	.112	.069	.421	.412	.117
Mexico	.063	.028	.533	.323	.445
New Zealand	.113	.062	.318	.273	.069
Norway	-.082	.018	.406	.406	-.742
Poland	.110	.013	.457	.355	.384
Sweden	.019	-.020	.352	.223	.046
Switzerland	.098	.027	.396	.396	.173
United Kingdom	.250	.048	.845	.618	.746
United States	.194	.045	1.087	1.044	.831
Euro zone (weighted avg)	.168	.020	.859	.826	.716
Mean	**.101**	**.019**	**.634**	**.521**	**.364**
Euro-zone countries:					
Austria	.202	.002	.706	.699	.480
Belgium	.133	-.005	.976	.968	.848
Estonia	.081	-.011	.085	.085	-.022
Finland	.077	-.004	.649	.632	.270
France	.130	.018	.974	.917	.889
Germany	.170	.011	.589	.562	.401
Greece	.303	.061	1.855	1.855	1.639
Ireland	.028	-.054	.570	.570	.488
Italy	.254	.035	1.341	1.282	1.217
Latvia	.110	-.011	.367	.329	.282
Lithuania	.159	.046	.358	.261	.303
Luxembourg	.039	-.060	.224	.224	-.141
Netherlands	.139	.006	.485	.484	.398
Portugal	.166	.040	1.166	1.133	1.099
Slovak Republic	.142	.031	.480	.456	.431
Slovenia	.184	-.001	.654	.619	.499
Spain	.238	.113	.982	.957	.837
Mean Euro zone	**.150**	**.013**	**.733**	**.708**	**.583**

Note: In column 1, excess government spending is calculated from general government expenditure exclusive of interest payments. Values are cumulative ratios to GDP for 2020-2022, expressed relative to the ratio for 2019. The missing value of interest payments for 2022 for South Korea is assumed to equal the value for 2021. In column 2, excess government revenue is calculated from general government revenue. Values are cumulative ratios to GDP for 2020-2022, expressed relative to the ratio for 2019. In column 3, gross public debt is observed at the end of 2019 for general government. In column 4, the adjusted gross public debt is net of shares denominated in foreign currency or in inflation-indexed form. In column 5, net public debt for general government at the end of 2019 is based on IMF criteria for netting.

Data are from IMF, *World Economic Outlook Data Base*, *Government Finance Statistics*, and *Article IV Staff Reports*. Column 4 uses information on shares of public debt denominated in foreign currency or in inflation-indexed form from Table 3, columns 3 and 4.

Table 3 Characteristics of Public Debt
37 OECD Countries (Turkey excluded)

	(1)	(2)	(3)	(4)	(5)
Country	**Average remaining maturity 2019**	**Estimated duration 2019**	**Share foreign-currency 2019**	**Share inflation-indexed 2019**	**Composite govt-spending variable**
Australia	7.7	6.8	.001	.051	.0269
Canada	6.3	5.9	.112	.037	.0413
Chile	11.9	8.9	.206	.394	.0861
Colombia	8.6	6.2	.227	.197	.0087
Costa Rica	6.4	4.5	.376	.053	-.0358
Czech Republic	6.1	5.8	.115	.000	.0983
Denmark	8.0	7.6	.040	.040	.0195
Hungary	4.6	4.2	.210	.053	.0539
Iceland	5.4	4.6	.165	.305	.1042
Israel	6.5	6.0	.145	.357	.0341
Japan	9.3	9.1	.001	.005	.0093
Korea, South	10.4	8.9	.010	.011	.0306
Mexico	9.9	6.9	.169	.218	.0280
New Zealand	7.7	6.7	.007	.111	.0600
Norway	4.0	3.8	.000	.000	-.0526
Poland	4.6	4.2	.220	.004	.0735
Sweden	5.0	4.9	.214	.162	.0174
Switzerland	10.4	10.0	.000	.000	.0248
United Kingdom	17.9	14.2	.000	.277	.0284
United States	5.7	5.3	.000	.061	.0353
Euro (weighted avg)	7.7	7.1	.014	.025	.0276
Mean	**7.8**	**6.8**	**.104**	**.141**	**.0254**
Euro-zone countries:					
Austria	9.9	9.1	.010	.000	.0317
Belgium	9.8	8.9	.008	.000	.0154
Estonia	7.2	7.2	.000	.000	.1328
Finland	6.3	6.1	.026	.000	.0199
France	8.2	7.7	.015	.045	.0185
Germany	6.9	6.7	.028	.021	.0451
Greece	9.6	6.8	.000	.000	.0241
Ireland	10.3	8.7	.000	.000	.0056
Italy	7.0	6.3	.007	.040	.0313
Latvia	9.9	8.5	.103	.000	.0393
Lithuania	7.4	6.8	.270	.000	.0890
Luxembourg	4.9	4.8	.000	.000	.0364
Netherlands	8.0	7.6	.003	.000	.0380
Portugal	6.2	5.6	.028	.000	.0263
Slovak Republic	8.8	8.0	.051	.000	.0390
Slovenia	9.0	7.9	.054	.000	.0377
Spain	7.7	6.9	.001	.027	.0359
Mean Euro zone	**8.1**	**7.3**	**.036**	**.007**	**.0392**

Note:

In column 1, average years of remaining maturity (applying only to principal payments) come in most cases from OECD, *Sovereign Outlook for OECD Countries, Survey on Central Government Marketable Debt and Borrowing*, 2023, Figure 1.14 for 2022; 2022, Figure 1.15 for 2020 and 2021; and 2021, Figure 1.14 for 2019. These values are for central government debt and were assumed to apply also to general government. Value for Estonia is for 2020. Value for Chile for 2022 is from Ministerio de Hacienda Chile, *Composition de la Deuda Chile by Currency,* March 2023. Value for Costa Rica for 2022 is from Ministerio de Hacienda, Costa Rica, *Profile of the Public Debt*, July 2023. Value for Iceland for 2022 is from Office of Debt Management *Newsletter*, Iceland, July 2023.

In column 2, the average duration of the public debt is calculated from the reported average maturity (column 1) from the formula in the Appendix, using data on nominal interest rates on long-term government bonds from 2007 to 2019 from *OECD.Stat* and IMF, *International Financial Statistics*. Data on interest rates begin in 2014 for Costa Rica and in 2015 for Estonia (approximated by 6-month Euribor interest rates reported by the Central Bank of Estonia). In the formula, the lagged interest rate, R_{t-L}, corresponds to the average going back from 2018 the number of years of duration. The current interest rate, R_t, corresponds to the rate for 2019. Since we lack separate data on maturity for bonds denominated in foreign currency or in inflation-indexed form, we made no adjustments to estimated duration because of these compositional differences.

In column 3, the share denominated in foreign currency is mostly from BIS, *Central and General Government Debt Securities Markets,* Table C4, 2020-2023. These values apply to long-term debt (maturity of one year or more) for general government. Sources for Costa Rica and Iceland are as above. Source for New Zealand is Reserve Bank of New Zealand, *Holdings of Central Government Debt Securities*, July 2023. For Costa Rica, Iceland, and New Zealand, the values of foreign-currency-denominated share for 2022 are assumed to apply also for 2019.

In column 4, the share inflation-indexed is mostly from BIS, Table C2, 2020-2023. These values are for central-government debt. Sources for Chile, Costa Rica, Iceland, and New Zealand are as above. Value for Japan for 2023 came from communication with the Bank of Japan. This value was assumed to apply also in 2019. Value for France for 2020 is from World Bank, *What Is the Role of Inflation-Linked Bonds for Sovereigns?*, 2022, Figure 2.5. Value for Sweden for 2022 is from CEICdata.com. Values of zero were confirmed by central banks of Norway and Switzerland. Reported inflation-indexed shares, which apply to central government, were multiplied by the ratio for 2019 of central to general government expenditure from IMF, *Government Finance Statistics*. The resulting values for inflation-indexed shares are estimated values for general government, assuming that only central governments issue inflation-linked bonds. For some countries, the values of inflation-indexed share for 2022 are assumed to apply for 2019.

In column 5, the composite government-spending variable is excess government spending from Table 2, column 1, divided by the ratio of gross public debt to GDP from Table 2, column 3, and divided by the estimated duration from Table 3, column 2.

Table 4

Means and Standard Deviations of Variables

	Mean	s.d.	Max	Min
Headline CPI inflation rate, 2010-2019	.0195	.0100	.0396	.0003
Headline CPI inflation rate, 2020-2022	.0423	.0197	.0768	.0075
Change in headline CPI inflation rate	.0228	.0162	.0601	.0028
Core CPI inflation rate, 2010-2019	.0180	.0100	.0360	-.0006
Core CPI inflation rate, 2020-2022	.0326	.0179	.0693	-.0010
Change in core CPI inflation rate	.0146	.0162	.0568	-.0123
Energy CPI inflation rate, 2010-2019	.0274	.0161	.0676	.0002
Energy CPI inflation rate, 2020-2022	.0984	.0412	.1688	.0261
Change in energy CPI inflation rate	.0710	.0454	.1445	-.0165
Food CPI inflation rate, 2010-2019	.0217	.0130	.0503	-.0018
Food CPI inflation rate, 2020-2022	.0594	.0342	.1341	.0005
Change in food CPI inflation rate	.0377	.0259	.0978	.0024
Δ(G/Y) (primary govt spending as ratio to GDP, cum. 2020-22 vs. 2019)	.1008	.0829	.2499	-.0820
Δ(REV/Y) (govt revenue as ratio to GDP, cum. 2020-22 vs 2019)	.0186	.0338	.0689	-.0681
Gross public debt/GDP (2019)	.634	.453	2.364	.283
Gross public debt adjusted/GDP (2019)	.521	.473	2.350	.125
Estimated public-debt duration (2019)	6.8	2.5	14.2	3.8
Composite govt-spending variable	.0254	.0286	.0870	-.0526
Composite govt-spending variable adjusted	.0343	.0380	.1042	-.0526
Composite govt-revenue variable	.0044	.0112	.0292	-.0209
Dummy for border with Ukraine or Russia	0.145	0.358	1	0

Note: Statistics refer to the 21 economies considered in Table 5 (20 non-Euro-zone countries and the weighted average of the 17 countries in the Euro zone). The headline and core CPI inflation rates are in Table 1. *Δ(G/Y)* is the cumulative ratio of primary general government expenditure to GDP from 2020 to 2022 expressed relative to the ratio for 2019 (Table 2, column 1). *Δ(REV/Y)* is the cumulative ratio of general government revenue to GDP from 2020 to 2022 expressed relative to the ratio for 2019 (Table 2, column 2). The estimated duration of the gross public debt in 2019 is from Table 3, column 2. The adjusted gross public debt (adjusted for amounts denominated in foreign currency or in inflation-linked form) is from Table 2, column 4. The composite government-spending variable from Table 3, column 5, equals *Δ(G/Y)* divided by the ratio of gross public debt to GDP in 2019 and by the estimated debt duration in 2019. The composite govt-spending variable adjusted uses instead the ratio of adjusted gross public debt to GDP. The composite government-revenue variable equals *Δ(REV/Y)* divided by the ratio of gross public debt to GDP in 2019 and by the estimated debt duration in 2019.

Table 5

Regressions for Change in Inflation Rate

Euro zone treated as one economy

	Headline CPI inflation rate		**Core CPI inflation rate**	
	(1)	**(2)**	**(3)**	**(4)**
Constant	0.0134** (0.0037)	0.0080*** (0.0025)	0.0038 (0.0033)	-0.0005 (0.0025)
Excess govt spending/(gross debt)* duration	0.369*** (0.099)	0.423*** (0.062)	0.422*** (0.087)	0.465*** (0.062)
Border with Ukraine or Russia	--	0.0278*** (0.0049)	--	0.0222*** (0.0049)
Number of observations	21	21	21	21
R-squared	0.423	0.791	0.555	0.790
s.e. of regression	0.0126	0.0078	0.0111	0.0078
log(likelihood)	63.05	73.71	65.84	73.73

Note: The sample is 21 economies (20 non-Euro zone and the Euro zone considered as an aggregate). For the Euro zone, each variable is a weighted average of the values for the 17 Euro-zone countries. The regressions are by OLS, with standard errors of estimated coefficients in parentheses. The dependent variable in column 1, shown in Table 1, column 1, is the average headline CPI inflation rate for 2020-2022 less that for 2010-2019. In column 2, the dependent variable, shown in Table 1, column 5, is the average core CPI inflation rate for 2020-2022 less that for 2010-2019. The composite government-spending variable equals the cumulation of ratios of general government primary spending to GDP from 2020 to 2022 expressed relative to the ratio for 2019 (Table 2, column 1), divided by the ratio of gross public debt to GDP in 2019 (Table 2, column 3) and by the estimated duration of the debt in 2019 (Table 3, column 2). The border dummy variable equals one for countries with a common border with Ukraine or Russia and equals zero otherwise.

Table 6

Regressions for Change in Inflation Rate

Euro zone treated as one economy, selected variables set at sample means

	Headline CPI inflation rate			Core CPI inflation rate		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Variable set at sample mean:	**Govt spending**	**Gross debt**	**Duration**	**Govt spending**	**Gross debt**	**Duration**
Constant	0.0102 (0.0075)	0.0109** (0.0041)	0.0053 (0.0035)	0.0008 (0.0079)	0.0028 (0.0043)	-0.0041 (0.0033)
Excess govt spending/(gross debt)*duration	0.300 (0.218)	0.355*** (0.118)	0.500*** (0.095)	0.373 (0.229)	0.388*** (0.126)	0.571*** (0.090)
Border with Ukraine or Russia	0.0165 (0.0099)	0.0254*** (0.0076)	0.0317*** (0.0061)	0.0088 (0.0104)	0.0195** (0.0081)	0.0269*** (0.0058)
Number of observations	21	21	21	21	21	21
R-squared	0.319	0.499	0.704	0.243	0.432	0.731
s.e. of regression	0.0141	0.0121	0.0093	0.0148	0.0128	0.0088
log(likelihood)	61.32	64.53	70.08	60.26	63.28	71.12
p-values:	0.000	0.000	0.007	0.000	0.000	0.025
Relative likelihood (AIC)	0.000	0.000	0.027	0.000	0.000	0.074

Note: See the notes to Table 5. The regressions for the headline CPI inflation rate correspond to Table 5, column 2. The ones for the core CPI inflation rate correspond to Table 5, column 4. Each column in Table 6 sets the indicated part of the composite government-spending variable for each country to its sample mean. These parts are excess government spending for 2020-2022 (Table 2, column 1), gross public debt as a ratio to GDP in 2019 (Table 2, column 3), and duration of the public debt in 2019 (Table 3, column 2). The p-values come from treating -2*log(likelihood ratio) as distributed asymptotically as a chi-squared variable with one degree of freedom. For headline CPI inflation, the calculations use the difference between the log(likelihood) shown in Table 5, column 2, from those shown in Table 6, columns 1-3 For core CPI inflation, the difference is between the log(likelihood) shown in Table 5, column 4, from those shown in Table 6, columns 4-6. The relative likelihood, based on the Akaike information criterion and using the same likelihood values, is the weight attached to the model in which the indicated variable is set at its sample mean and, therefore, does not contribute to the explanation of the cross-sectional variations in inflation rates. One minus these relative likelihoods is the weight attached to the model shown in Table 5, column 2 or 4.

***significant at 1%.
**significant at 5%.
*significant at 10%

Table 7

Regressions for Change in Inflation Rate

Euro-zone countries considered individually

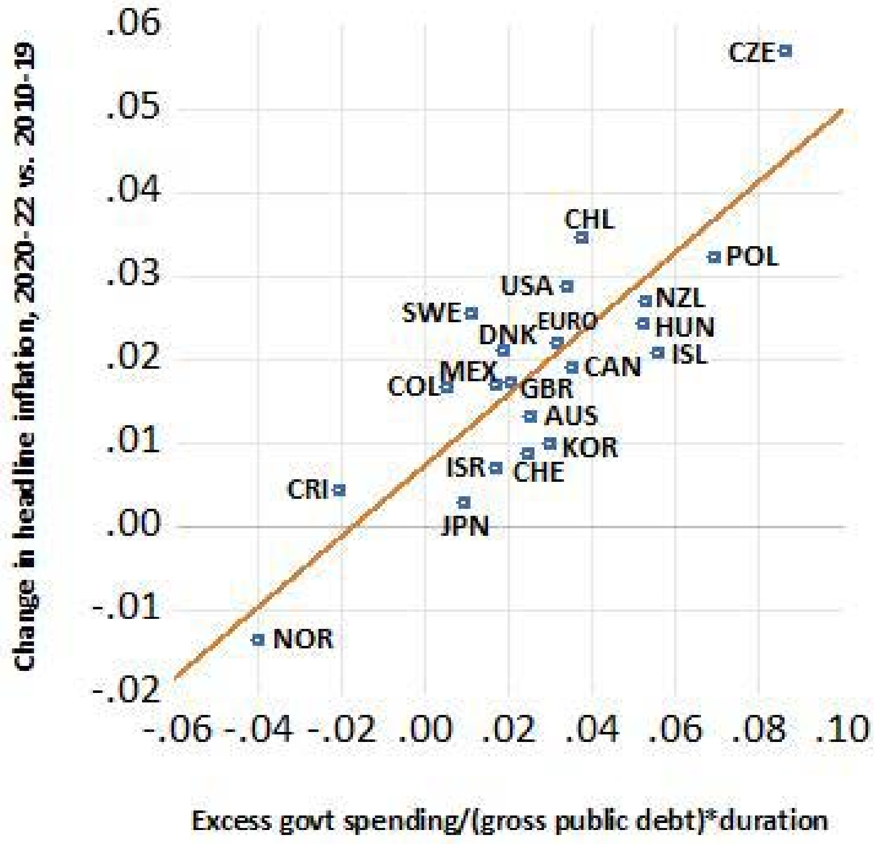
	Headline CPI inflation rate		Core CPI inflation rate	
	(1)	**(2)**	**(3)**	**(4)**
Constant	0.0152*** (0.0034)	0.0092*** (0.0022)	0.0032 (0.0028)	-0.0010 (0.0022)
Excess govt spending/(gross debt)* duration	0.374*** (0.099)	0.422*** (0.061)	0.420*** (0.083)	0.455*** (0.062)
Excess govt spending/(gross debt)* duration: Euro area	0.353*** (0.109)	0.125* (0.073)	0.160* (0.092)	-0.005 (0.074)
Border with Ukraine or Russia	--	0.0258*** (0.0034)	--	0.0186*** (0.0034)
Number of observations	37	37	37	37
R-squared	0.424	0.790	0.460	0.714
s.e. of regression	0.0126	0.0077	0.0106	0.0078
log(likelihood)	110.791	129.493	117.270	129.010

Note: The regressions correspond to Table 5. The first government-spending variable is the same as that in Table 5, where the value for each of the 17 Euro-zone countries equals the weighted average of values for these countries. The second government-spending variable is each Euro-zone country's individual value less the weighted average of this variable for the 17 Euro-zone countries.

***significant at 1%.
**significant at 5%.
*significant at 10%

Figure 1

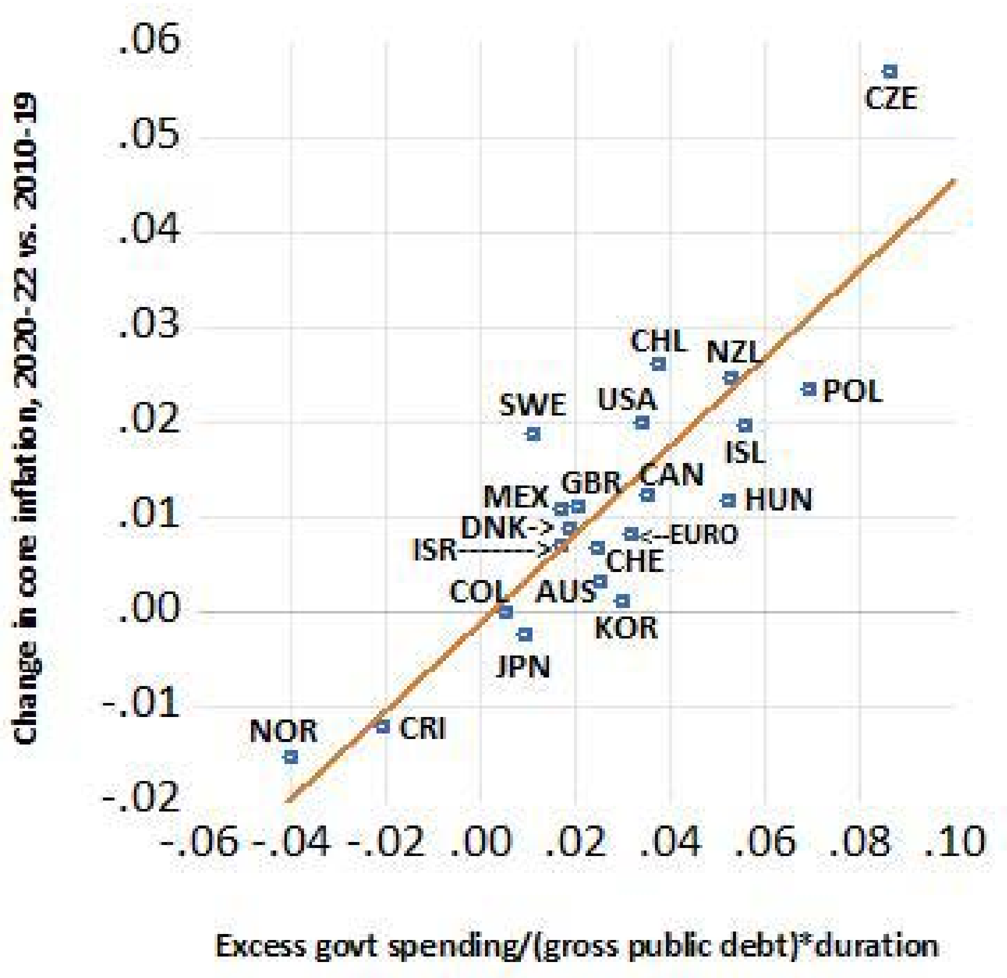
Change in Headline CPI Inflation Rate versus Government Spending



Note: The sample is 21 economies—20 non-Euro countries plus the Euro zone considered as an aggregate. The labels are standard acronyms for countries (used, for example, by the IMF). The vertical axis has the change in the headline CPI inflation rate. This variable is the average rate for 2020-2022 minus that for 2010-2019 (Table 1, column 1). The spending variable is the ratio of general government primary spending to GDP (cumulation for 2020-2022 relative to the ratio for 2019 in Table 2, column 1) divided by the ratio of gross public debt to GDP in 2019 (Table 2, column 3) and by the estimated duration of the debt in 2019 (Table 3, column 2). The variables on the vertical and horizontal axes have been filtered out for estimated relationships with the border dummy variable.

Figure 2

Change in Core CPI Inflation Rate versus Government Spending

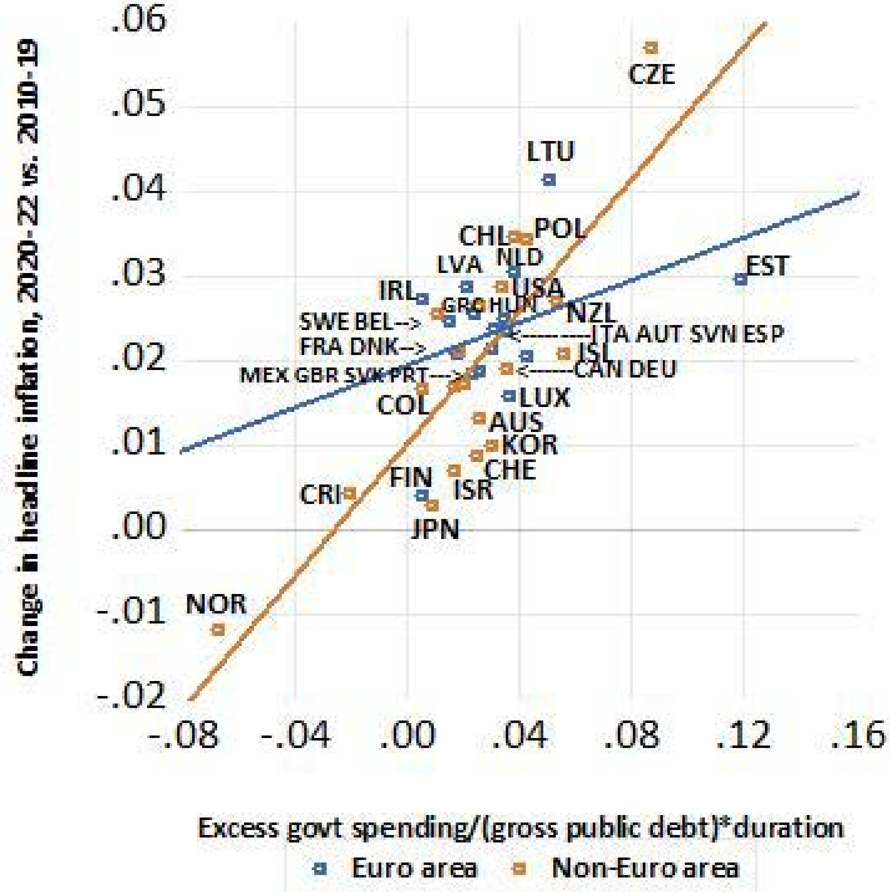


Note: See the notes to Figure 1. The difference from Figure 1 is that the inflation rates are based on core CPI inflation rates (Table 1, column 5).

Figure 3

Change in Headline CPI Inflation Rate versus Government Spending

Euro-zone countries considered separately

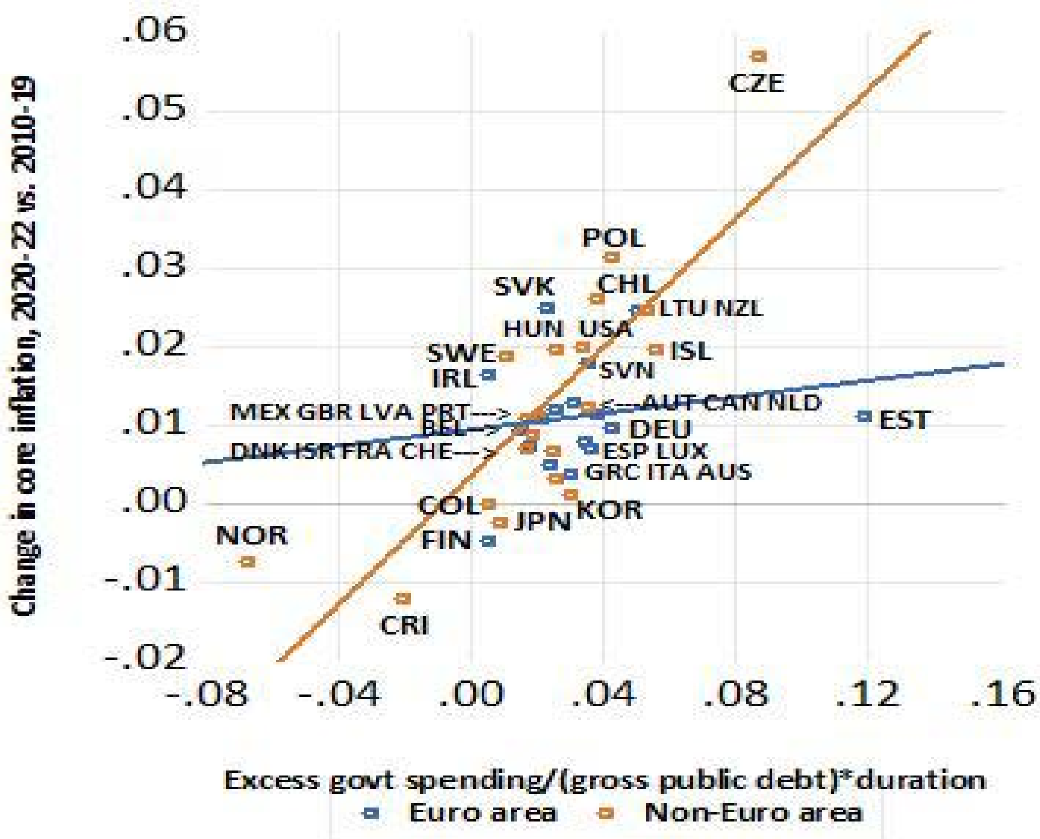


Note: See the notes to Figure 1. The difference is that the sample comprises 37 OECD countries, of which the Euro area has 17 countries and the non-Euro area has 20 countries.

Figure 4

Change in Core CPI Inflation Rate versus Government Spending

Euro-zone countries considered separately



Note: See the notes to Figures 1 and 3. The difference from Figure 3 is that the inflation rates are based on core CPI inflation rates (Table 1, column 5).

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Appendix

A1. Formula for estimated duration of bonds

At time t, the outstanding nominal coupons and principal payment on a bond are $B_t^0, B_t^1, \ldots, B_t^T$. Unlike in the main text, these amounts now apply to a single bond, not to the coupons and principal payments for the aggregates of bonds outstanding. Consider a "standard" bond that has constant nominal coupons followed by a single nominal principal payment at *T*, so that $B_t^0 = B_t^1 = \cdots B_t^{T-1} = B_t^i$. In that case, the standard data would report *T* to be the remaining maturity of the bond.

If the nominal discount rate at time *t* is R_t (applying to all future periods), the value of the bond is

$$\text{(A1)} \qquad B_t = B_t^i[1 + \frac{1}{(1+R_t)} + \cdots + \frac{1}{(1+R_t)^{T-1}}] + \frac{B_t^T}{(1+R_t)^T}$$

This result assumes that each coupon or principal payment occurs at the beginning of each period (where a period corresponds here to the time between payments of coupons or principal). Evaluating the sum leads to

$$\text{(A2)} \qquad B_t = \frac{B_t^i}{R_t}[1 + R_t - \left(\frac{1}{1+R_t}\right)^{T-1}] + \frac{B_t^T}{(1+R_t)^T}$$

The Macaulay (1938, Chapter II) duration of the bond is

$$\text{(A3)} \qquad D_t = \frac{B_t^i}{B_t} \cdot [\frac{1}{(1+R_t)} + \frac{1}{(1+R_t)^2} \cdot 2 + \cdots + \frac{1}{(1+R_t)^{T-1}} \cdot (T-1)] + \frac{B_t^T}{B_t(1+R_t)^T} \cdot T$$

Evaluating the sum inside the brackets (using Jolley, 1961, series 5) and simplifying leads to:

$$\text{(A4)} \qquad D_t = \frac{B_t^i}{B_t} \cdot \frac{1}{R_t^2}[1 + R_t - \frac{1}{(1+R_t)^{T-1}}(1 + R_t T)] + \frac{B_t^T}{B_t(1+R_t)^T} \cdot T$$

The ratio B_t^i/B_t^T is the coupon yield of the bond. For a bond issued currently at par—which we take to be the typical case for bonds—this yield would equal R_t. However, the coupon yields of long-term bonds outstanding at the start of period *t* would reflect past issues. We assume that the coupon yield on each of these bonds equals the discount rate that applied when the bonds were issued. In that case, B_t^i/B_t^T would correspond to an average of past discount rates, which we denote by R_{t-L}. Making this substitution into equations (A4) and (A2) leads to:

$$\text{(A5)} \qquad D_t = \frac{B_t^T}{B_t} \cdot \left\{ \frac{R_{t-L}}{R_t^2} \left[1 + R_t - \frac{1}{(1+R_t)^{T-1}} (1 + R_t T) \right] + \frac{T}{(1+R_t)^T} \right\}$$

$$\text{(A6)} \qquad B_t = B_t^T \cdot \left\{ \frac{R_{t-L}}{R_t} \left[1 + R_t - \frac{1}{(1+R_t)^{T-1}} \right] + \frac{1}{(1+R_t)^T} \right\}$$

Substitution for B_t from Eq. (A6) into Eq. (A5) leads to the formula for duration:

$$\text{(A7)} \qquad D_t = \frac{\left\{ \frac{R_{t-L}}{R_t^2} \left[1+R_t - \frac{1}{(1+R_t)^{T-1}} (1+R_t T) \right] + \frac{T}{(1+R_t)^T} \right\}}{\left\{ \frac{R_{t-L}}{R_t} \left[1+R_t - \frac{1}{(1+R_t)^{T-1}} \right] + \frac{1}{(1+R_t)^T} \right\}}$$

Note that D_t in Eq. (A7) can be computed from the reported average remaining time to maturity, which corresponds to *T* in the formula, the current interest rate on long-term government bonds, R_t, and the lagged value of this interest rate, R_{t-L}. In the empirical analysis, R_t is the long-term interest rate on government bonds in 2019 and R_{t-L} is the average of long-term interest rates on government bonds covering the period up to 2018 and going back D_t years. (The estimation involves a recursion, but only two steps were required in practice.) The important properties of the formula are that D_t is less than the reported average maturity, *T*, increasing in *T*, and decreasing in R_{t-L}, which determines the coupon yield. The estimated value of D_t for each country in 2019 is in Table 3, column 2.

A2. Regressions using adjusted gross public debt.

Table A1

Regressions for Change in Inflation Rate

Euro zone treated as one country

	Headline CPI inflation rate		Core CPI inflation rate	
	(1)	**(2)**	**(3)**	**(4)**
Constant	0.0135** (0.0038)	0.0089*** (0.0029)	0.0036 (0.0033)	0.0000 (0.0027)
Excess govt spending/(gross debt)* duration	0.271*** (0.076)	0.296*** (0.053)	0.317*** (0.065)	0.337*** (0.050)
Border with Ukraine or Russia	--	0.0259*** (0.0056)	--	0.0202*** (0.0053)
Number of observations	21	21	21	21
R-squared	0.401	0.723	0.554	0.724
s.e. of regression	0.0129	0.0090	0.0111	0.0085
log(likelihood)	62.66	70.77	65.81	71.94

Note: These regressions are the same as those in Table 5 except that the composite government-spending variable is based on the gross public debt adjusted for shares denominated in foreign currency or in inflation-indexed form (Table 2, column 4).

Table A2

Regressions for Change in Inflation Rate

Euro-zone countries considered individually

	Headline CPI inflation rate		**Core CPI inflation rate**	
	(1)	**(2)**	**(3)**	**(4)**
Constant	0.0164*** (0.0032)	0.0114*** (0.0023)	0.0039 (0.0026)	0.0003 (0.0021)
Excess govt spending/(adjusted gross debt)*duration	0.260*** (0.073)	0.286*** (0.050)	0.317*** (0.061)	0.336*** (0.047)
Excess govt spending/(adjusted gross debt)*duration: Euro area	0.386*** (0.101)	0.169** (0.077)	0.196** (0.084)	0.038 (0.072)
Border with Ukraine or Russia	--	0.0242*** (0.0038)	--	0.0176*** (0.0036)
Number of observations	37	37	37	37
R-squared	0.439	0.748	0.485	0.704
s.e. of regression	0.0125	0.0085	0.0104	0.0080
log(likelihood)	111.266	126.114	118.172	128.389

Note: These regressions are the same as those in Table 7 except that the composite government-spending variable is based on the gross public debt adjusted for shares denominated in foreign currency or in inflation-indexed form (Table 2, column 4).

***significant at 1%.
**significant at 5%.
*significant at 10%