Fiscal Influences on Inflation in OECD Countries, 2020-2022

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Fiscal Theory of the Price Level, FTPL

- Theory around since early 1990s.
- Not taken seriously by mainstream macroeconomists as empirical model of inflation.
- Reasons: inflation associated much more with monetary policy; inflation low & stable many countries mid 1980s to 2020.
- Surge of inflation along with surge in fiscal deficits in many countries made economists more receptive to idea of FTPL.

Empirical Study for OECD Countries

- Determinants of headline & core CPI inflation rates across 37 OECD countries, 2020-2022.
- Empirical framework based on simple version of FTPL.
- Frictionless version of model, no nominal rigidities. Abstract from effects on inflation from changes in real interest rates, etc.

Government's Intertemporal Budget Constraint

Centerpiece of FTPL is government's intertemporal budget constraint:

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

- B_t : nominal market value short- and long-term public debt, start of period t.
- P_t : price level start of period t.
- T_t, G_t : real taxes, real primary spending period t.
- r: constant real interest rate.
- Assumes no-Ponzi condition for long-term financing.
- Stock of real government bonds equals p.v. of real primary surpluses.

Spending Surge

- Crisis, such as COVID pandemic (or war), leads to unexpected surge in G_{t+i}, $i = 0, \ldots, M$. Present value of changes:

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

- Assume temporary surge. After M periods, G returns to previous path. Changes unanticipated before period t; then fully known.

- Can have analogous shift in real government revenue. Empirically, spending surge dominates for 2020-2022. For 37 OECD countries, cumulative shift in ratio of spending to GDP averages 12%, 1.6% for revenue.

Government Bonds

- If Y_t grows at constant rate $g=r$ (from date t to $t+M$), Eq.(2) can be written as:

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

- At time t, aggregate amounts of nominal payouts on government bonds due at start of each period are $B_t^0, B_t^1, \ldots, B_t^T$, where T is maximum debt maturity. B_t^i is total of coupons and principal payments due at $t+i$. Total nominal market value of government bonds outstanding at start of period t is

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

Inflation

- π_{t+i} is inflation rate for period $t+i$. Assumption is that inflation rates unknown before period t but fully anticipated as of start of period t. Therefore, if R_{t+i} is nominal interest rate for period $t+i$, rate moves along with inflation rate, $(1+R_{t+i})=(1+r)\cdot(1+\pi_{t+i})$.

- To simplify, aggregate nominal payments on bonds assumed to rise over time with baseline (past) inflation rate, π^*, and growth rate of real GDP, $g=r$. That is, government arranges composition of public debt so that, in absence of shocks, payments rise with nominal GDP. Eq.(5) then becomes:

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

Inflation Surge

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

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

where B_t^* is baseline nominal value of public debt; value prior to deviation of inflation rates from baseline.

- Reaction to surge in spending from Eq.(4) assumed to be surge in inflation rates, π_{t+1}, …, π_{t+T}, above π^*. Assumption is π^* fixed. Shifts in inflation rates, when anticipated, lower nominal market value of bonds outstanding in accordance with Eq.(6). (Rules out jump in price level at start of period *t*, though could be introduced.) Lowering of real value of public debt effectively pays for part of increase in present value of real primary deficits in Eq.(4).

Change in Real Value of Public Debt

- Change in nominal market value of debt generated by shift in (actual and expected) inflation rates from π^* to sequence $\pi_{t+1}, \ldots \pi_{t+T}$ given from Eq.(6) by

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

- Boost to inflation rates, $\pi_{t+i} > \pi^*$, implies negative value of ΔB.

- As stressed by Cochrane (2001), multiplicity of future inflation rates correspond to given ΔB. If debt maturity, T, long, part of inflation surge can occur in distant future. Cochrane argues may be optimal to smooth out boost to inflation rates; monetary policy assumed able to achieve desired path of inflation, while generating given ΔB in Eq.(8). Fiscal & monetary authorities effectively cooperate here.

- Work with time path of inflation rates, not changes in monetary instruments, including short-term nominal interest rates, that support path. Focus on extreme smoothing in which higher inflation rate, π_{t+i}, constant at $\pi > \pi^*$ for $i=1, \ldots, T$. Eq.(8) simplifies to:

Required Inflation Rate

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

Assumes $\pi > \pi^*$. Expression includes maximum debt maturity, *T*. If approximate $\left(\frac{1+\pi*}{1+\pi}\right)^T$ with second-order expansion around one, assuming $(\pi-\pi^*)\cdot T << 1$, Eq. (9) simplifies to:

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

- Negative value of ΔB corresponds to boost in inflation rate, $\pi > \pi*$. Given ΔB, larger values of B_t^* or T associate with smaller values of $\pi - \pi*$.

Formula for Inflation Rate

- If surge in inflation "financed" 100% of increase in government expenditure, magnitude of real value $\Delta B/P_t$, where ΔB in Eq.(10), would equal present value of increase in real primary deficits from Eq.(4). Generalize to case where surge in inflation pays for fraction η of spending surge; fraction 1-η paid for by cuts in spending beyond *t+M* or increases in current or future government revenue. Expression for rise in inflation rate:

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

- Underlying assumption that initial debt-GDP ratio, $\frac{B_t^*}{P_t Y_t}$, large enough to cover $\Delta\left(\frac{G}{Y}\right)$ term.
- *T/2* represents "average maturity" of outstanding stock of public debt. Eq. (11) implies non-negative slope coefficient, η, and intercept of zero; that is, $\pi = \pi^*$ when $\Delta\left(\frac{G}{Y}\right)$ term is zero.

State-Contingent Public Finance

- $\eta=0$ when surge in government spending matched by expectations of offsetting cuts in spending further in future or increases in current and future government revenue. Corresponds to standard intertemporal public finance in sense of government always respecting constraint that increase in today's real primary deficit balanced by corresponding reductions in future real primary deficits (all measured as real present values).

- $\eta=0$ holds in most circumstances, with $\eta>0$ applying only during economic emergencies, such as COVID crisis or large war. Discussion fits with state-contingent fiscal-deficit policies of Lucas/ Stokey (1983) in context of wartime, notably WWII. Upshot is fiscal deficits and inflation not much related during "normal" economic times but could be closely connected during unusual events. Perspective fits with empirical application to OECD countries in context of COVID crisis.

Functional Form for Empirical Work

- Equation (11) provides functional form for empirical work. Form implies, not surprisingly, that rise in inflation rate higher the larger cumulative rise in G_{t+i}/Y_{t+i}, $i=0, \ldots, M$.

- Less intuitively, rise in inflation rate larger the *smaller* baseline debt-GDP ratio, B_t^*/P_tY_t. Result follows because smaller debt-GDP ratio implies higher inflation rate required to get decline in real market value of public debt needed to balance surge in real primary deficits.

- Higher average debt maturity, $T/2$, also implies smaller rise in inflation rate. Reason is that, with cumulative increase in G/Y held fixed and inflation rate equalized over T periods, higher T implies smaller inflation rate required each period to generate requisite reduction in real public debt.

Ukraine-Russia War

- Overall, model says that inflation rate reacts to composite government-spending variable, which equals cumulative surge in ratios of government spending to GDP divided by initial debt-GDP ratio and average debt maturity.

- Empirical application to inflation rates allows for additional effect from Ukraine-Russia War (started 2022). Countries that share common border with Ukraine or Russia found to have higher inflation rates than would otherwise be predicted.

- From perspective of Eq. (11), effects from Ukraine/Russia War can be viewed as reflecting choices to finance more or less government expenditure through inflation or to deviate more or less from smoothing of inflation rates to place more or less weight on short-term inflation.

Data

- **CPI Inflation rates**
- Headline and core CPI inflation rates from OECD.STAT.

- **Government spending**
- Data from IMF (mostly WEO) on ratio of general govt spending exclusive of interest payments to GDP.

- **Quantities of public debt**
- Data from IMF (mostly WEO) on ratio of general govt gross public debt to GDP.
- Adjustment for amounts denominated in foreign currency or inflation-linked form?
- Net versus gross debt?
- Treatment of central bank?

Data

- **Duration of public debt**
- Data from OECD on “average remaining maturity” of general govt gross public debt (also BIS). Refers to principal payments, not coupons. Approximation to calculate duration of debt, using formula that factors in stated maturity along with current and lagged nominal interest rates on government bonds.

- **Euro-area data**
- Weighted averages of 17 countries with Euro area viewed as single economy.

- **Proximity to war in Ukraine**
- Assembled information related to distances and trade shares. Empirically, results best with simple dummy variable for whether country shares common border with Ukraine or Russia (8 OECD countries).

Identification

- Assume composite govt-spending variable exogenous with respect to inflation. Empirically, spending variable relates negligibly to extent of economic downturn gauged by real GDP growth 2019-2020. Have not found good instruments—COVID outcomes do not work.

- Identification comes from cross-sectional variation across OECD countries. Setting precludes country fixed effects. Relying on "old-style econometrics." Results similar using annual time series of inflation 2010-2022 with country fixed effects (picking up constant inflation target for each country).

Empirical Setup

- Sample comprises 37 OECD countries (all except Turkey), 20 outside Euro zone, 17 Euro zone. Because of common currency with single central bank, main setting treats Euro zone as single economy (with variables measured as weighted averages).

- Table 1, cols. 1 & 2, has headline inflation; cols. 3 & 4, core inflation. Cols. 1 & 3 use only composite govt-spending variable. Cols. 2 & 4 add Ukraine-Russia border dummy.

- Coefficient of govt-spending variable corresponds to η in model; share of spending "financed" by unanticipated inflation.

Table 1: 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
Regressions by OLS, s.e.'s in parentheses. Dependent variable is inflation rate for 2020-22 less that for 2010-19.				
***significant at 1%, **significant at 5%, *significant at 10%				

Empirical results on government spending

- Estimated coefficients of govt-spending variable in cols. 1 & 3 positive, around 0.4, highly significant.

- In cols. 2 & 4, Ukraine-Russia border dummy positive, highly significant, sharply raises R-squared. Moderately raises coefficient of govt-spending variable—to 0.42 and 0.46 for headline, core, respectively.

- Estimated coefficients of govt-spending variable significantly less than one. Around 40-50% of spending surge financed by unanticipated inflation, rest by standard public finance.

Inflation versus Govt Spending

- Figures 1 & 2 depict relationship between change in CPI inflation rate (headline & core, respectively) and govt-spending variable. (Effects of border dummy filtered out here.)

- U.S. not outlier. Lies moderately above average for govt-spending variable (0.034 vs. 0.025) and changes in inflation rates (headline: 0.029 vs. 0.023; core: 0.020 vs. 0.015). Euro area below U.S. for inflation (headline: 0.023; core: 0.009) and govt-spending variable (0.029).

- Figures show clear positive slopes that do not seem to be driven by extreme observations.

Figure 1
Change in headline CPI inflation rate versus govt spending

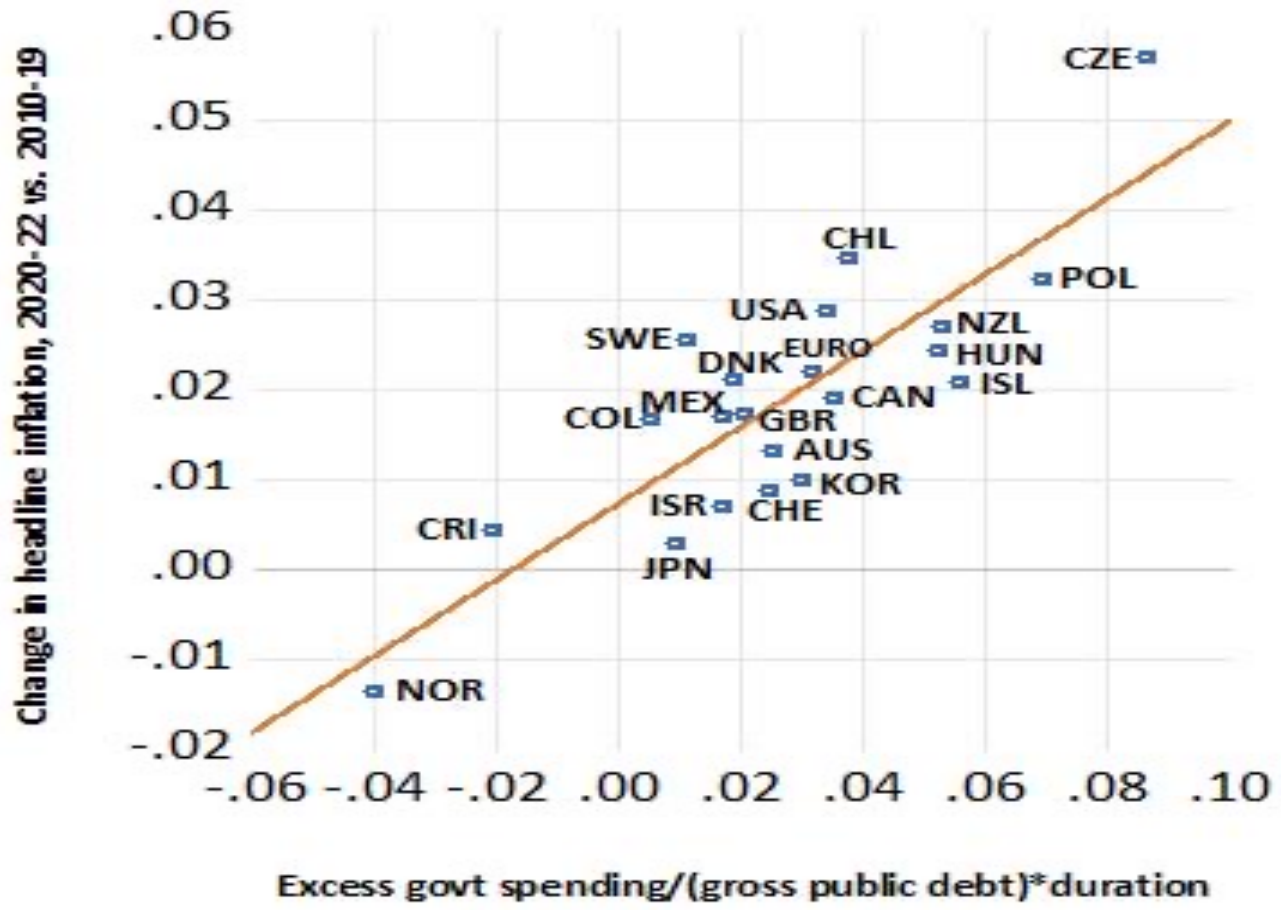
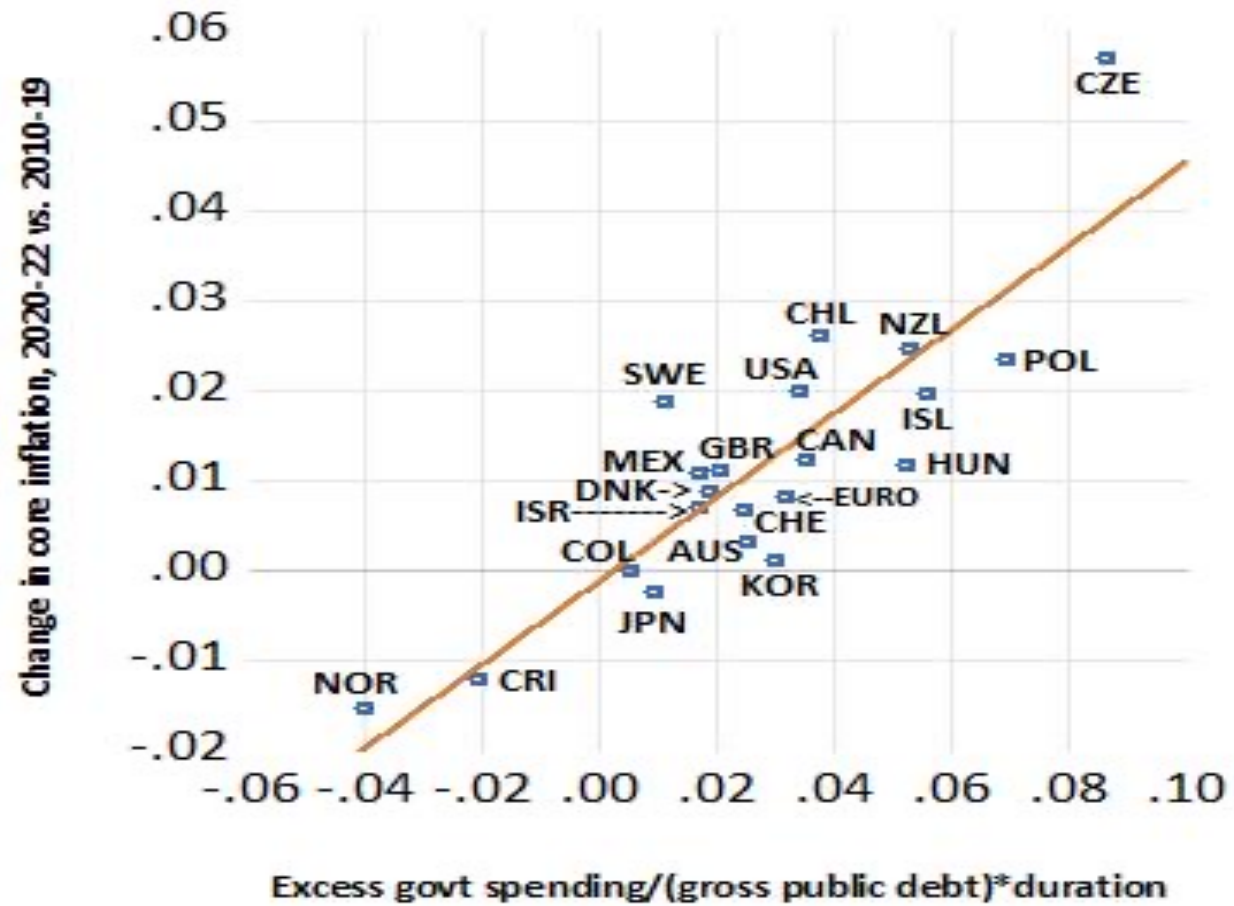


Figure 2
Change in core CPI inflation rate versus govt spending



Components of Govt-Spending Variable

- Composite government-spending variable equals *Δ(G/Y)*, cumulation from 2020 to 2022 of ratios of general government spending to GDP gauged relative to ratios for 2019, divided by ratio of gross public debt to GDP in 2019 and debt duration in 2019. As noted, estimated coefficients positive and highly statistically significant.

- Can assess how statistical significance of composite government-spending variable relates to contributions from three components: *Δ(G/Y)*, debt-GDP ratio, debt duration. Focus on cases from Table 5, columns 2 and 4, that include border dummy for Ukraine/Russia.

- Each component of government-spending variable set, one at a time, at sample mean. That is, designated variable restricted not to contribute to explanation of cross-sectional variations in inflation rates. First approach: think of constraint as amounting to one coefficient restriction imposed on estimation. Then test validity of restriction from condition that -2*log(likelihood ratio) distributed asymptotically as Chi-squared variable with one degree of freedom.

Results for govt spending, initial public debt, initial debt duration

- p-value for *Δ(G/Y)* 0.000 for headline and core inflation rates.
- Same conclusion for 2019 ratio of public debt to GDP.
- Duration of public debt in 2019 also significant (p-value 0.007 for headline inflation, 0.025 for core).

Results with AIC

- Second approach uses Akaike Information Criterion (AIC), also based on likelihood ratio.

- Similar conclusions. For duration, weight on model that sets this variable to sample mean is 0.027 for headline inflation, 0.074 for core.

Border Dummy Variable

- For border dummy, estimated coefficient for core inflation almost as large as headline. Main effect likely not through energy prices.

- When estimated only through 2021, estimated coefficient on border dummy about one-third size as that through 2022. Still statistically significant at 5% for headline inflation, not core.

Lagged inflation

- Model examines inflation rate 2020-2022 relative to baseline rate for 2010-2019. (Means of inflation rates 2020-2022 are 0.042 headline, 0.033 core. For 2010-2019, 0.020 headline, 0.018 core.)

- With inflation rate 2020-2022 as dependent variable, estimated coefficients on inflation rate 2010-2019 are 1.21 (s.e.=0.17) headline, 0.97 (0.18) core. (Similar results with country fixed effects using annual time series back to 2010. Fixed effect gives estimate for each country of fixed inflation-rate target.)

Euro-zone countries entered separately

- Table 2. First G-variable same as Table 1; Euro countries have Euro-area weighted average. Second G-variable for Euro zone is individual G variable relative to Euro-area average. With border dummy included, estimated coefficient on second variable differs insignificantly from zero at 5% level: 0.12 (0.07) headline, 0.00 (0.07) core.

- One constant term and one coefficient for border dummy.

- Main conclusion is aggregating Euro-zone countries into one economy satisfactory for analyzing effects of G variable on inflation rates. (But border dummy affects Euro countries individually.)

- See Figures 3 & 4 on results.

Table 2: Regressions for Change in Inflation Rate Euro-zone countries entered 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: Table 1	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

Regressions by OLS, s.e.'s in parentheses. Dependent variable is inflation rate for 2020-22 less that for 2010-19.

***significant at 1%, **significant at 5%, *significant at 10%

Figure 3
Change in headline CPI inflation rate versus govt spending

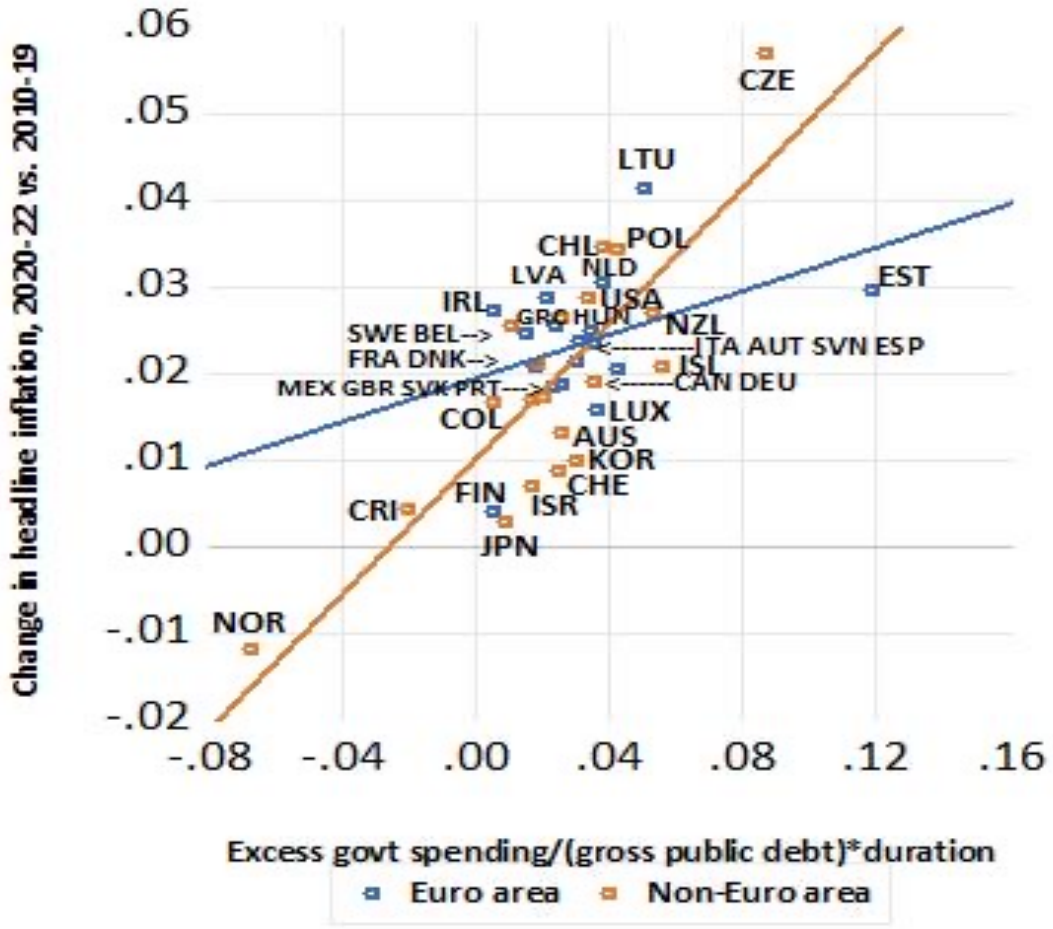
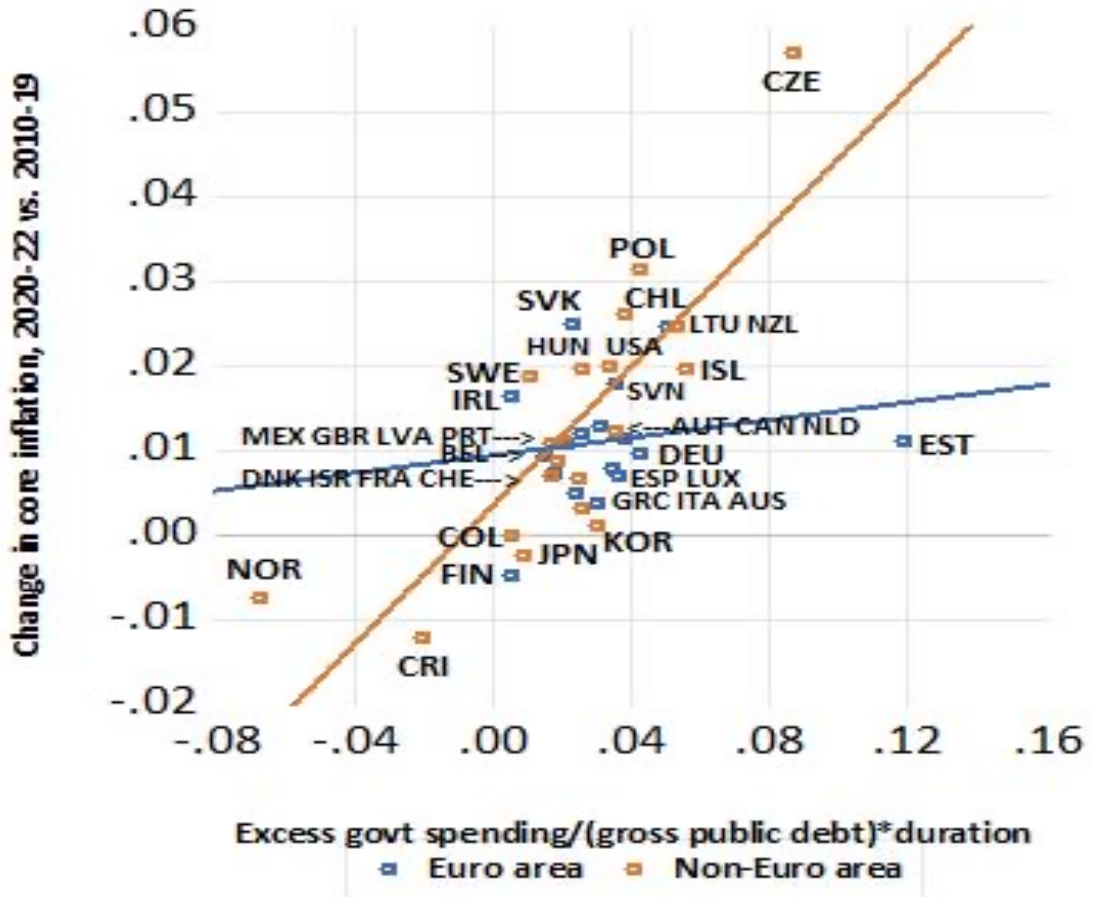


Figure 4
Change in core CPI inflation rate versus govt spending



Conclusions

- In response to COVID pandemic, many countries implemented large increases in deficit-financed government spending 2020 to 2022. To extent fiscal interventions perceived as not backed by current and future tax increases or future spending cuts, fiscal theory of price level, FTPL, predicts rise in inflation rates.

- In setting that neglects effects on inflation from changes in real variables, predicted increases in inflation rates proportional to size of fiscal stimulus, measured by increases in ratio of primary govt. spending to GDP. For given fiscal stimulus, country's surge in inflation lower if starts with larger ratio of public debt to GDP or longer duration of debt.

Conclusions

- Support for theoretical predictions of FTPL in OECD data. 21 economies—20 non-Euro-zone and aggregate of 17 Euro-zone—headline and core inflation rates 2020-2022 responded positively to theory-motivated government-spending variable. Across 17 Euro-zone countries, differences in government-spending variable do not generate significant differences in inflation rates; each country responds to Euro-area aggregate.

- While positive and statistically significant, coefficient that gauges response of inflation rate to scaled measure of government spending significantly less than one, value predicted when all extra spending "paid for" through surprise inflation. Coefficients of 0.4-0.5 suggest 40-50% of extra spending financed through inflation. Remaining 50-60% through conventional intertemporal public finance—increases in current or prospective government revenue or cuts in prospective future primary spending.

Current Research

- Adding in 9 non-OECD countries: Brazil, Croatia, India, Indonesia, Malaysia, Peru, Singapore, South Africa, Thailand.
- Will add data for 2023.
- Will apply to U.S. states. Analogous to Euro zone?
- Policy implications: was it a mistake to have the inflation surge, contingent on paths of fiscal deficits?

Regressions with country fixed effects 2010-2022

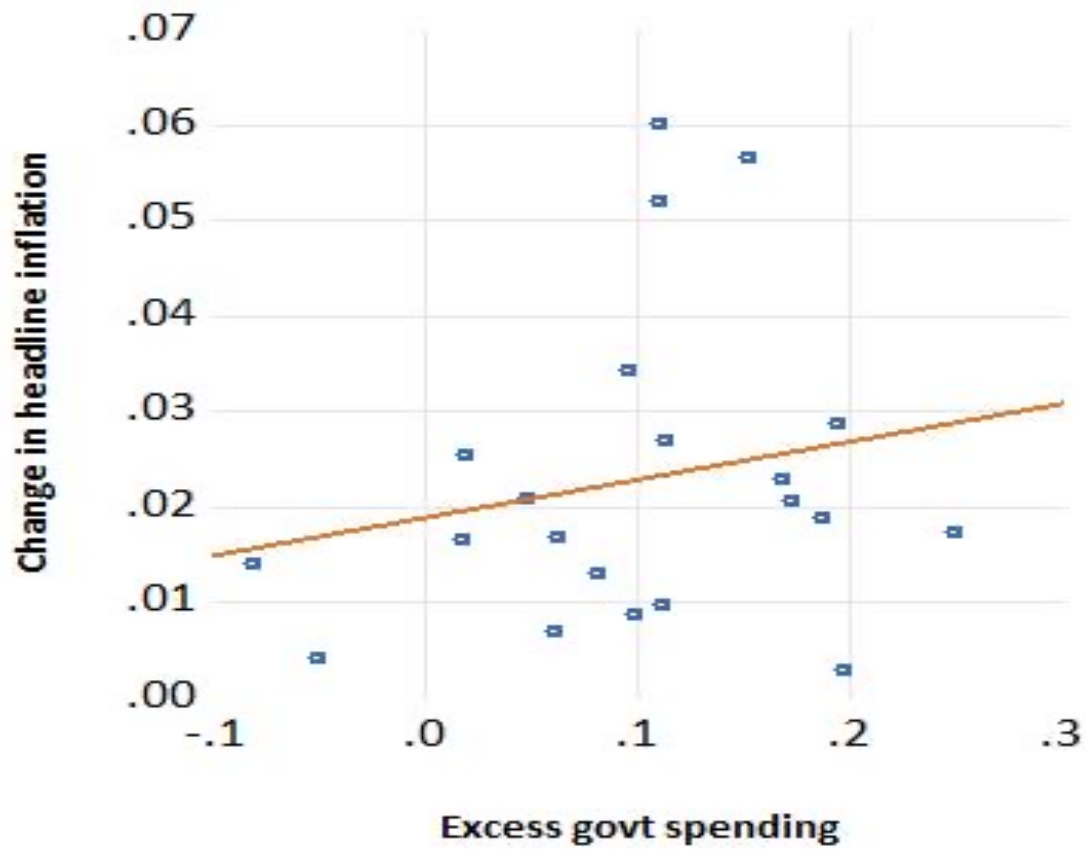
$$\pi \text{ (headline CPI)} = \underset{(.0012)}{0.0205^{***}} + \underset{(.068)}{0.565^{***}} \cdot \text{composite G variable} + \underset{(.0107)}{0.0861^{***}} \cdot \text{border}$$

R-squared=0.49, σ=0.018, N = 21 countries, 273 observations

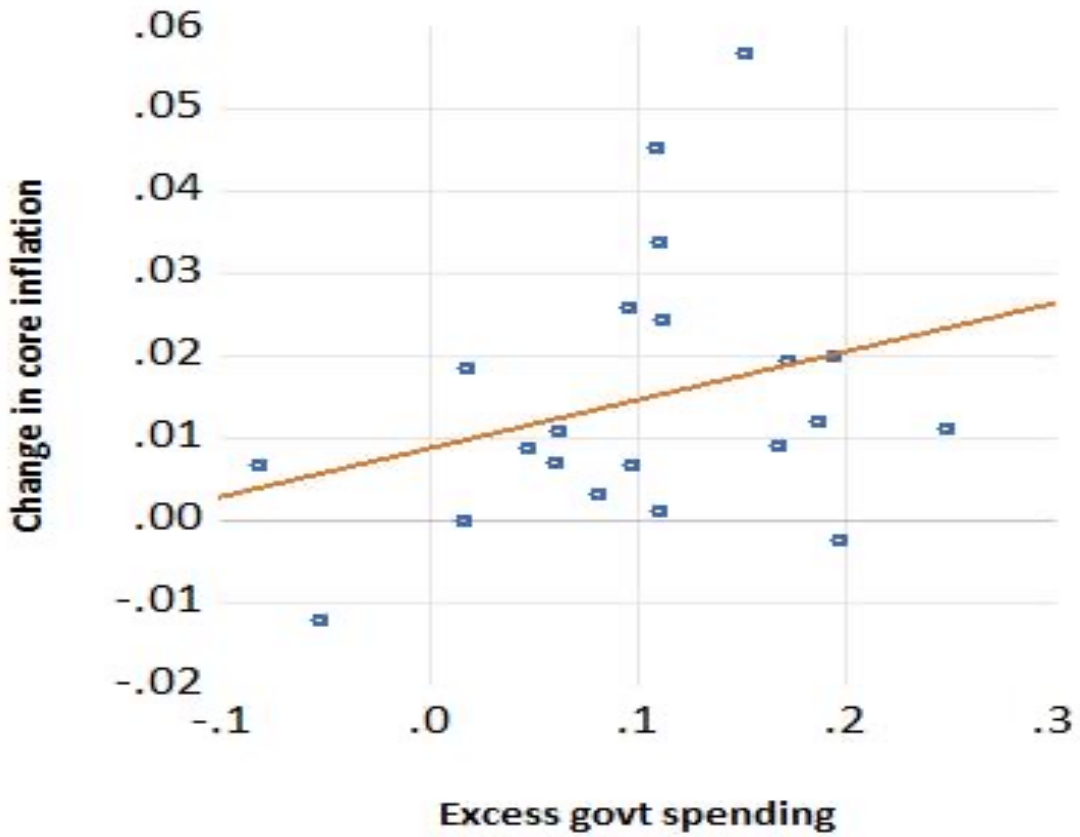
$$\pi \text{ (core CPI)} = \underset{(.0008)}{0.0181^{***}} + \underset{(.047)}{0.466^{***}} \cdot \text{composite G variable} + \underset{(.0074)}{0.0491^{***}} \cdot \text{border}$$

R-squared=0.57, σ=0.012, N = 21 countries, 273 observations

Use only excess government spending Headline CPI



Use only excess government spending Core CPI



Evolution of Gross Debt-GDP Ratios