Box III.3.1: The effects of an adverse terms-of-trade shock on debt dynamics in quest simulations

This box assesses the impact of higher inflation on debt dynamics, based on simulations using the Commission's QUEST model ([1]). Higher inflation is usually expected to be directly beneficial for public finances, as tax revenue tends to grow in line with inflation while public expenditure might adjust only with a delay. In addition, faster price growth can lower the debt-to-GDP ratio via the denominator effect, essentially eroding the real value of nominally fixed debt. But beyond these direct impacts of inflation, debt dynamics are also influenced by a host of other factors, which are likely to change depending on the source of inflation and on how economic policy responds. QUEST, a general equilibrium macroeconomic model, is useful to show in a consistent way how these economic variables interact with each other in response to different shocks, providing a more complete view of the determinants of fiscal dynamics. As there is no such thing as a "pure" inflation shock that leaves the rest of the economy unchanged, it is important to identify the underlying structural economic shock that causes rising inflation. For instance, inflation can increase due to a positive domestic demand shock, which stimulates growth and puts upward pressure on prices (demand-pull inflation). Alternatively, inflation can also result from a negative supply shock, which depresses real growth (cost-push inflation). These shocks have very different implications for debt dynamics.

The simulations isolate the effects of an adverse terms-of-trade shock for the EU as a whole. While arguably not the only source, a sharply deteriorating terms-of-trade (ToT) shock was undoubtedly an important driver of the surge in inflation in 2022. Such a shock raises import prices relative to export prices, and thereby drives a wedge between the consumer price index (the price of what households consume, including imports) and the GDP deflator (the price of what the domestic economy produces, including exports). This wedge represents a terms-of-trade loss, that erodes the purchasing power of the domestic economy as a whole, pushing *real domestic income* (CPI-deflated nominal GDP) below real GDP ([2]). At the same time, the shock depresses real GDP itself, as imported intermediate inputs for domestic production become more costly (supply effect), and the weakening purchasing power of households lowers demand not just for imports but also for domestically produced goods (demand effect). Monetary policy responds to rising consumer inflation by raising short term nominal interest rates more than one-for-one, such that increasing real interest rates depress economic growth further beyond the direct impact of the shock, while also mitigating the rise in inflation. The illustrative ToT shock is designed such that CPI inflation rises (temporarily) by 1 percentage point under the baseline scenario, in a version of QUEST that is calibrated to the European Union as a whole versus the rest of the world ([3]).

The primary budget balance declines in response to an adverse ToT shock (Graph 1, left panel). This is mainly driven by expenditures such as transfers (e.g. pensions) that are assumed to be indexed to rising consumer prices under our baseline calibration, and which therefore increase as a share of GDP when real GDP declines and the GDP deflator grows less than CPI. Automatic stabilisers such as unemployment benefits also increase as the real economy weakens. Government consumption and public investment are assumed to be fixed as a share of GDP, so they have no effect by construction. On the other hand, tax revenues increase somewhat (as a share of GDP), mainly due to the "fiscal drag" effect coming from initially not adjusting the nominal brackets of a progressive labour tax system in the face of nominal wage inflation. VAT revenues also rise because of the opening wedge between the CPI and GDP deflator, while consumption volumes are slower to moderate. However, these positive revenue effects are not large enough to offset the effect of higher expenditures, so overall the primary deficit widens. Importantly, this scenario assumes no discretionary

([1]) The details of these simulations are published in Motyovszki, Gergő (2023). The fiscal effects of terms-of-trade driven inflation. *European Economy Discussion Papers*, (forthcoming).

([2]) A corollary to this is that despite sharply increasing CPI inflation, nominal GDP is not necessarily growing as fast. Therefore, for fiscal indicators expressed as a share of nominal GDP, it is the more benign GDP deflator that is the relevant inflation indicator.

([3]) The scenario is illustrative and does not intend to capture the actual size of the ToT shock that hit Europe. That said, this calibration implies a cumulative 10% decline of the model economy's ToT during the first two years, which is the same order of magnitude as the EU's observed ToT-deterioration of cumulative 9% over 2021-22.

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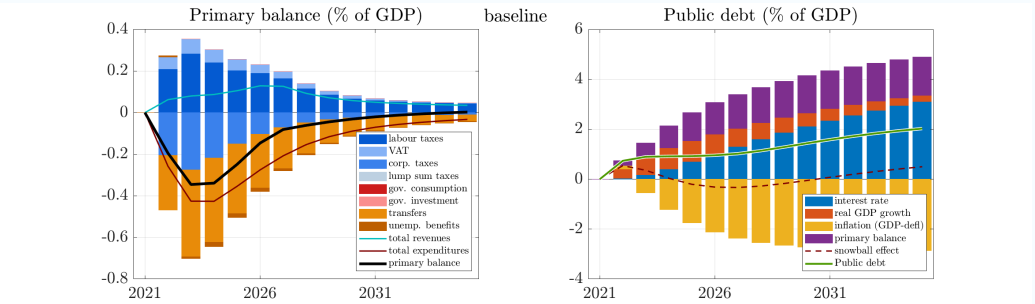
reaction from fiscal policy either in response to the rising cost of living, or in response to the increasing debt-to-GDP ratio, in order to isolate the effect of the shock.

Graph 1: **Impulse responses to a series of unexpected adverse terms-of-trade shocks in the EU.**



Source: European Commission staff calculations - simulations by QUEST, calibrated for the EU-27.

Overall, the ToT deterioration leads to an increase in the debt-to-GDP ratio (Graph 1, right panel)**.** The reason is that the debt-reducing effect of higher inflation is outweighed by the adverse effects of slower real growth, higher interest rates and a declining primary balance ([4]). Monetary tightening via short term interest rates passes through to higher effective interest payments on public debt, albeit only gradually, as government bonds in the EU have a rather long average maturity of 7 years. However, despite sharply increasing CPI inflation, GDP-deflator growth also builds up only gradually, as second round effects on domestic prices gain strength later on. Combined with weaker real growth, this is sufficient to keep the "snowball effect" (nominal interest-growth differential) from becoming too negative. The widening primary deficit contributes to the rise in public debt beyond this snowball effect.

The results crucially depend on monetary policy and debt management settings (Graph 2). A more aggressive monetary tightening in response to inflationary pressures (stricter inflation targeting) constrains aggregate demand via higher real interest rates, leading to lower GDP growth and inflation. This entails a larger decline in the primary balance, while a more "hawkish" monetary stance also raises the effective interest rate on public debt, directly pushing up interest payments. All of these factors contribute to increasing the debt-to-GDP ratio. In contrast, with an initially unresponsive monetary policy (ZLB scenario), the opposite happens. Results even change in qualitative terms, leading to an outright fall in debt-to-GDP as the erosive effect of higher inflation now dominates (borne by bondholders), and the primary balance increases on the back of relatively higher growth. Finally, shorter debt maturity (2 years) would speed up the rise in debt-to-GDP ratios, as higher short-term rates would feed much quicker into effective debt financing costs. This

([4]) The chart decomposes the dynamics of the cumulative change in the public debt-to-GDP ratio $\hat{d}_T$ according to the following equation, where pb_t is the primary budget balance as a percent of GDP, i^g_{t-1} is the *effective* nominal interest rate on the outstanding government debt stock, π_t is inflation (GDP-deflator) and g_t is the growth rate of real GDP. The last three terms sum up to the "snowball effect", i.e. the interest-growth differential, which operates *on top of* the effects of inflation and real growth on the primary balance itself. This relationship holds as a matter of accounting identity, and its components may interact with each other, so the individual terms do not perfectly isolate the "effect" of each variable. However, it can still help us to map the transmission channels of the shock propagation:

$$\hat{d}_T = \sum_{t=2022}^{T} \Delta d_t = \sum_{t=2022}^{T} \left\{ -pb_t + \frac{i^g_{t-1}}{(1+\pi_t)(1+g_t)} d_{t-1} - \frac{g_t}{(1+\pi_t)(1+g_t)} d_{t-1} - \frac{\pi_t}{1+\pi_t} d_{t-1} \right\}$$

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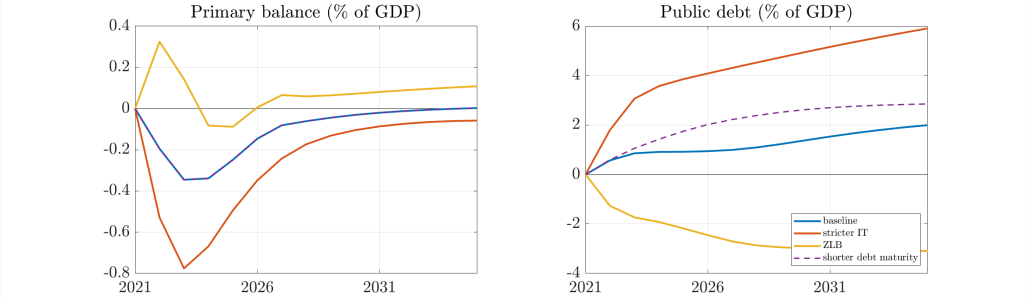
scenario might be especially relevant in light of past bond purchases by central banks which have drastically shortened the duration of the *consolidated* government's liabilities ([5]).

Graph 2: **Impulse responses to an adverse terms-of-trade shock under alternative monetary policy settings (EU)**



Source: European Commission staff calculations - simulations by QUEST, calibrated for the EU-27.

The findings are also sensitive to indexation assumptions concerning public expenditure (Graph 3). *Fixing government consumption and investment* (in addition to transfers) in real terms, amid falling real domestic income, raises the primary deficit and public debt further relative to the baseline scenario – despite also contributing to somewhat higher real growth and inflation. In contrast, *freezing all these expenditure items in nominal terms* eventually eases the pressure on public finances, as they become eroded as a share of a higher nominal GDP. The burden of this fiscal adjustment would be borne by the recipients of these expenditures (e.g. pensioners and civil servants), who would see their real disposable income decline further. This scenario provides an illustration of a significant "benefit erosion", whereby government expenditures fail to keep up with inflation ([6]). *Indexing transfers to nominal wages* is in between these two extreme scenarios. Relative to the baseline, where transfers are indexed to CPI, this assumption leads to higher primary balances and more stable debt dynamics, since nominal wages grow less than CPI inflation (i.e. CPI-deflated real wages are falling).

Finally, we consider alternative fiscal settings on the revenue side. In our baseline scenario with a progressive labour tax system, the fact that nominal tax brackets are not immediately adjusted in line with wage inflation, raises the average labour tax rate as the wage distribution shifts into higher brackets. This "fiscal drag" raises tax revenue and supports the primary balance. In contrast to this baseline scenario, under a linear labour tax system (or in a progressive tax system where tax brackets are adjusted in real time with wage inflation), this fiscal drag effect is missing, whereas under an even more progressive tax system it is

([5]) The fiscal costs of rising short term interest rates might materialize sooner than suggested by general government debt maturities, due to the losses that rising short rates create for taxpayer-owned central banks who had previously purchased large amounts of long government bonds. As the central bank balance sheet is not modelled explicitly in QUEST, we can capture this effect by treating public debt in the model as that of the *consolidated* government (i.e. central bank and treasury combined) – instead of restricting it to *general* government debt. In other words, it is a kind of synthetic liability for the consolidated government, a portfolio of long treasury bonds and short central bank reserves in the hands of the private sector.

([6]) Note however that the primary balance initially declines slightly even under this benefit erosion scenario, due to a temporarily declining nominal GDP. This is because right after the ToT shock, in addition to declining real GDP, the GDP deflator temporarily falls. This is explained by the only gradual pass-through of more expensive imported inputs to gross output prices, as well as by the downward pressure on domestic prices stemming from weaker demand. As the pass-through progresses, and domestic workers and firms attempt to recover their (CPI-deflated) real income losses, the GDP deflator starts to increase, but under our baseline monetary policy settings, such second-round effects to domestic prices are not strong enough to dominate immediately after the shock.

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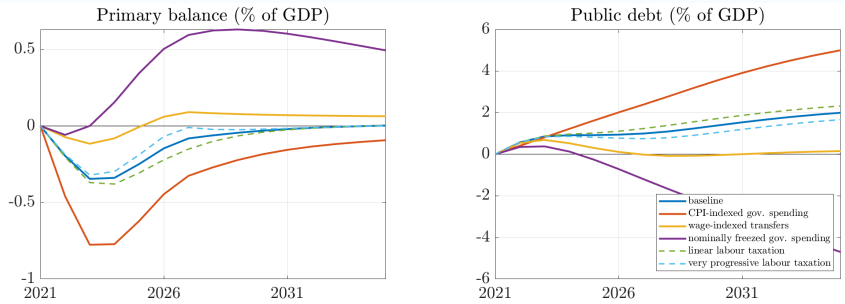
stronger. While this has some impact on households' disposable income, as Graph 3 shows, in terms of debt dynamics it makes a much smaller quantitative difference than varying expenditure-indexation rules ([7]).

Graph 3: **Impulse responses to an adverse terms-of-trade shock under alternative fiscal policy settings (EU)**



Source: European Commission staff calculations - simulations by QUEST, calibrated for the EU-27.

A positive demand shock, with the *same* inflationary impact as the adverse ToT shock, would have qualitatively opposite fiscal effects (Graph 4) ([8]). In order to highlight the importance of the underlying source of inflation, we consider an illustrative exercise with a positive demand shock. Despite having similar inflationary consequences, such a shock entails starkly different macroeconomic and fiscal implications. In this case, rising CPI inflation goes together with higher real GDP as well as an even faster-increasing GDP-deflator (due to the domestic source of inflation). As a result, the primary balance rises which, combined with beneficial snowball effects stemming mainly from higher nominal growth, pulls down the debt-to-GDP ratio ([9]). Graph 4 also displays the effects of rising firm markups, i.e. a negative supply shock that originates from the *domestic* economy. This has qualitatively similar fiscal implications as the adverse terms-of-trade shock (that originates from *abroad*), however, the domestic (as opposed to external) origins of the supply shock make a difference for the time profile and transmission channels of the effects.

([7]) This is also due to the only gradual development of second-round effects. The fiscal drag phenomenon relies on fast-increasing nominal wages. However, as second-round effects develop only gradually, the increase in nominal wages is not as strong in the beginning, and would only contribute noticeably to the fiscal drag later on, by which time the tax brackets are likely to be adjusted. In our simulations, they are fixed for 5 years.

([8]) Similar conclusions are reached by Bankowski, Krzysztof, Othman Bouabdallah, Cristina Checherita-Westphal, Maximilian Freier, Pascal Jacquinot, and Philip Muggenthaler. 2023. "Fiscal policy and high inflation." *ECB Economic Bulletin*, 2023(2), https://www.ecb.europa.eu/pub/economic-bulletin/articles/2023/html/ecb.ebart202302_01~2bd46eff8f.en.html.

([9]) Note that the central bank raises nominal interest rates similarly, given the similar inflationary impact. For a demand shock there's some additional monetary tightening initially, responding to stronger real output, but it is not sufficient to offset the larger increase in higher nominal growth within the snowball effects.

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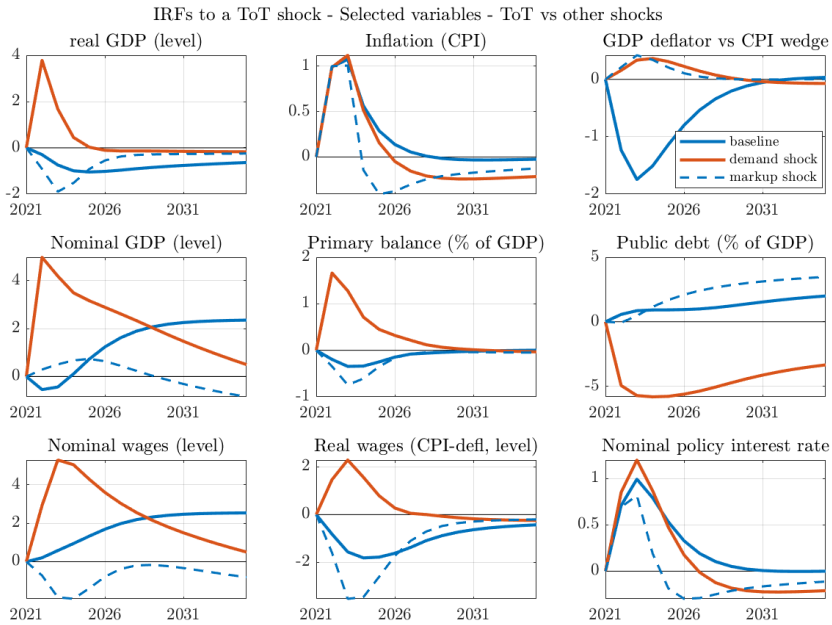
Graph 4: **Impulse responses to different types of shocks (EU)**



Source: European Commission staff calculations - simulations by QUEST, calibrated for the EU-27.

Inflation in Europe is likely driven by a combination of different types of shocks, so the relevant fiscal effects are most probably a mix of the clean scenarios discussed here. However, to the extent that the terms-of-trade shock was an important factor, this analysis attempted to isolate its effects, and capture its less familiar transmission channels. At the same time, the simulations also emphasize the importance of identifying the underlying source of inflation for estimating the fiscal consequences. The takeaway is that not all types of inflationary shocks are necessarily beneficial for debt-sustainability. In particular, despite raising inflation, a deteriorating terms-of-trade offers little scope for "inflating away" public debt.

Under certain policy settings public debt can indeed follow a lower trajectory, but this comes with some trade-offs. The burden of the implicit fiscal consolidation behind stabilising the debt-to-GDP ratio is always borne by some domestic agents, be it transfer-recipients (with nominally frozen public expenditures) or long-term bondholders (when monetary policy tolerates higher inflation). In other words, the terms-of-trade shock makes the economy as a whole worse off, by lowering real gross domestic income, so it has an inherently detrimental effect – public finances can benefit from this situation only to the extent that some other sector of the economy pays for it. On top of this, the higher inflation path or lower degree of fiscal income insurance associated with these policies might entail further welfare costs, but these are beyond the scope of this descriptive analysis.