I. TERMS-OF-TRADE-DRIVEN INFLATION AND MONETARY-FISCAL POLICIES

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Abstract: *This chapter looks at whether the recent sharp spike in inflation can be beneficial for public debt sustainability by eroding the real value of nominal debt. Simulations with the European Commission's QUEST model suggest that, if the source of inflation is an adverse terms-of-trade shock, then it leads to a rising public debt-to-GDP ratio instead. In this case, the debt-reducing effect of higher inflation is outweighed by the adverse effects of slower real growth, a declining primary budget balance, and higher interest rates as an active monetary policy tightens to fight inflationary pressures. The results are policy-dependent: shorter debt maturity (e.g. as brought about by past QE programs) would speed up the rise in interest expenditures, while a more accommodative monetary policy would delay them, also supporting nominal growth. The initial terms-of-trade loss triggers second round domestic price pressures as economic agents strive to recover their purchasing power, and the emergence of such wage-price spirals is found to interact strongly with the reaction of monetary policy. The reaction of the primary fiscal balance (via automatic stabilisers, inflation indexation and debt-stabilisation rules) also matters. However, the baseline result that the debt-to-GDP ratio rises in response to an adverse terms-of-trade shock is fairly robust across all but the most extreme alternative policy scenarios. The source of the inflationary shock is crucial for these results as demand-driven inflation would have opposite fiscal implications. The results of the chapter should not be blindly applied to the observed inflation development, which was driven by a combination of different economic shocks. ([1])*

I.1. INTRODUCTION

In 2021-22 Europe experienced a surge in inflation. While high inflation is usually regarded as economically costly, this has also raised the question whether the situation can be beneficial for public finances and debt sustainability. The real value of nominal (i.e. not inflation-indexed) local currency debt can be eroded by faster-than-expected price growth, which could *ceteris paribus* lower public debt-to-GDP ratios. Higher inflation could also raise the budget balance, as tax revenue tends to grow in line with inflation while public expenditure might adjust only with a delay.

However, beyond inflation, debt dynamics depend on a host of other factors as well (e.g. real growth or interest rates), which are likely to change and interact with each other as the shocks at the origin of higher inflation propagate through the economy. Moreover, the precise way these interactions unfold depends on the source of inflation and on how economic policy responds. Therefore, *a priori,* how inflationary shocks might affect debt sustainability is ambiguous.

To investigate these general equilibrium fiscal dynamics after an increase in inflation in a model-consistent way, this chapter presents simulations for the European Union done with the Commission's macroeconomic model, QUEST.

First, as there is no such thing as an "immaculate" inflation shock that leaves the rest of the economy unchanged, it is important to identify the underlying economic shock that caused inflation to rise.

([1]) The details of these simulations and the underlying model are published in Motyovszki, Gergő (2023). The Fiscal Effects of Terms-of-Trade-Driven Inflation. *European Economy Discussion Papers*, DP-190 (July 2023), **Error! Hyperlink reference not valid.**.

Inflation can increase due to a positive domestic demand shock, which stimulates growth and puts upward pressure on prices (demand-pull inflation), but it can also result from a negative supply shock, like a rise in domestic markups, commodity prices or a hit to productivity, which depress real growth while leading to higher prices (cost-push inflation). Beyond different outcomes for GDP, monetary and fiscal policies are also likely to react in very dissimilar ways, affecting not just interest payments and the primary balance, but also feeding back to inflation and real growth. Different inflationary shocks therefore have very different implications for debt dynamics, which are a result of a complex interaction of all the above.

Due to surging imported energy prices, over the course of 2021-22 Europe saw its terms-of-trade (ToT) deteriorate by almost 9% cumulatively. While arguably not the only source of rising prices, this was undoubtedly an important driver behind the increase in European inflation. For this reason, the stylised model simulations presented in this chapter isolate the effects of an adverse terms-of-trade shock for the EU as a whole and illustrate the transmission channels of such a disturbance for fiscal dynamics.

It should be noted that the actual evolution of inflation in Europe was driven by a combination of various economic shocks, not only the terms-of-trade shock. Most notably, the post-pandemic reopening with the associated pent-up demand of households, supply-chain disruptions and tightening supply bottlenecks have constituted a complex mixture of demand and supply shocks. However, rather than conducting a historical shock decomposition exercise trying to replicate Europe's recent experience, the analysis in this paper attempts to isolate the effect of the terms-of-trade shock only, in order to capture its transmission channels without confounding the picture with other disturbances.

An adverse terms-of-trade (ToT) shock raises import prices relative to export prices, and thereby drives a wedge between the consumer price index and the GDP deflator. This wedge represents a terms-of-trade loss, that erodes the purchasing power of the domestic economy as a whole, pushing *real gross domestic income* (CPI-deflated nominal GDP) below real GDP. 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). In our baseline scenario monetary policy responds promptly to rising consumer inflation by raising short term nominal interest rates.

The main finding from this exercise is that despite its inflationary effect, an adverse terms-of-trade shock leads to a *rising* public debt-to-GDP ratio. The reason is that the debt-reducing effect of higher inflation is outweighed by the detrimental effects of slower real growth, higher interest rates, and a declining primary budget balance. Despite not considering any *discretionary* fiscal response to the rising cost-of-living, the primary balance falls as a share of GDP, driven mainly by CPI-indexed transfer expenditures (e.g. pensions) at a time when CPI-deflated nominal GDP is falling.

Another finding is that the quantitative results depend crucially on various monetary, fiscal and debt management policy settings. When monetary policy raises interest rates less aggressively in response to inflationary pressures, it slows debt dynamics not only directly via financing costs on government bonds, but also indirectly by supporting aggregate demand, and therefore real growth and inflation. In contrast, a shorter average maturity of the outstanding debt stock increases the speed with which rising short term policy rates pass through into effective government financing costs – a highly relevant scenario when the duration of the *consolidated* government's liabilities has been drastically shortened by past QE programs. The reaction of the primary fiscal balance (via automatic stabilisers, inflation indexation and debt-stabilisation rules) also matters. However, the baseline result that the debt-to-GDP ratio rises in

response to an adverse terms-of-trade shock is fairly robust across all but the most extreme alternative policy scenarios ([2]).

Finally, the simulations highlight the importance of the source of the inflationary shock: a demand-driven inflation of similar magnitude would have qualitatively opposite fiscal implications, *improving* debt sustainability. To the extent that inflation in Europe was driven by both terms-of-trade and demand shocks, the *actual* evolution of public finances reflected a mixture of these two clean effects. Irrespective of which shocks actually dominated in the EU, the takeaway of our analysis 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.

The rest of this chapter is structured as follows. Section I.1. describes the macroeconomic transmission channels of a ToT shock both in the real economy and for inflation, while Section I.2. looks at the fiscal implications of these macroeconomic consequences. Section I.3. considers alternative monetary-fiscal policy settings, while Section I.4. explores other types of inflationary shocks. Section I.5. concludes.

I.2. MACROECONOMIC TRANSMISSION CHANNELS OF A TERMS-OF-TRADE SHOCK

I.2.1. Real income and terms-of-trade loss

The illustrative ToT shock is modelled as an exogenous rise in import prices and is designed such that CPI inflation in the EU rises by 1 percentage point under the baseline scenario ([3]). Rising import prices have a *direct* first round effect on consumer price inflation as imported goods are part of the final consumption basket – as well as an *indirect* first round effect via imported intermediate inputs in domestic production. To the extent that domestic producers can pass on their rising imported input costs, the price of domestically produced goods in the consumption basket also increases, even before taking into account any second-round effects in the price index of domestic value added, i.e. the GDP-deflator (see top right panel of Graph I.1).

By making Europe's imports more expensive relative to the products it exports, a deteriorating terms-of-trade drives a wedge between final consumer prices (the price of what households consume, including imports) and the GDP-deflator (the price of what the domestic economy produces, including exports) ([4]). This wedge represents a *terms-of-trade loss*, that erodes the purchasing power of the European economy as a whole. Essentially, the value added Europe produces, expressed in terms of the basket of goods it consumes (i.e. *real gross domestic income*), declines even if the volume of production (real GDP) remained unchanged (see upper left panel of Graph I.1). The ToT loss also has a major impact on the evolution of the trade balance (see bottom left panel Graph I.1), where adverse relative price effects

([2]) This might seem to contrast with the observed *fall* of debt-to-GDP across the EU during this period. However, in the very short term after an inflationary shock, actual policy is in fact quite likely to be characterised by these most extreme *stylised* policy scenarios, under which debt-to-GDP declines. These feature a nominal freeze on government expenditures ("benefit erosion"), or non-immediate monetary tightening, even if policy is later adjusted.

([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.

([4]) 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.

initially dominate beneficial volume effects, leading to a deficit and raising the external financing needs of the domestic economy.

In addition to lowering real incomes through the ToT loss, the shock also leads to a fall in real GDP itself. Domestic production is hit both via demand and supply channels. On the demand side, there are two counteracting forces. On the one hand, the declining real income of households depresses their overall consumption, since some of them are liquidity constrained and cannot smooth their consumption in the face of fluctuating real incomes. If consumed in unchanged proportions, this would lower demand not just for imports but also for domestically produced goods, *hurting* GDP. On the other hand, the increase in the relative price of imports induces some substitution away from them and towards domestic goods, which *supports* GDP. In other words, the deteriorating terms-of-trade erodes the purchasing power of the domestic economy, while at the same time also making it more competitive: the negative *income effects* are being counteracted by beneficial *expenditure switching* effects. As Auclert et al (2023) show, the balance of these forces depends on the degree to which consumption smoothing is available (e.g. the share of liquidity constrained households) and on the elasticity of substitution between imported and domestically produced goods ([5]).

In our baseline simulations domestic demand is also hurt via intertemporal substitution channels, as an active monetary policy responds to rising consumer inflation by raising short term nominal interest rates more than one-for-one. The resulting increase in real interest rates discourages spending and consumption smoothing even by non-constrained households.

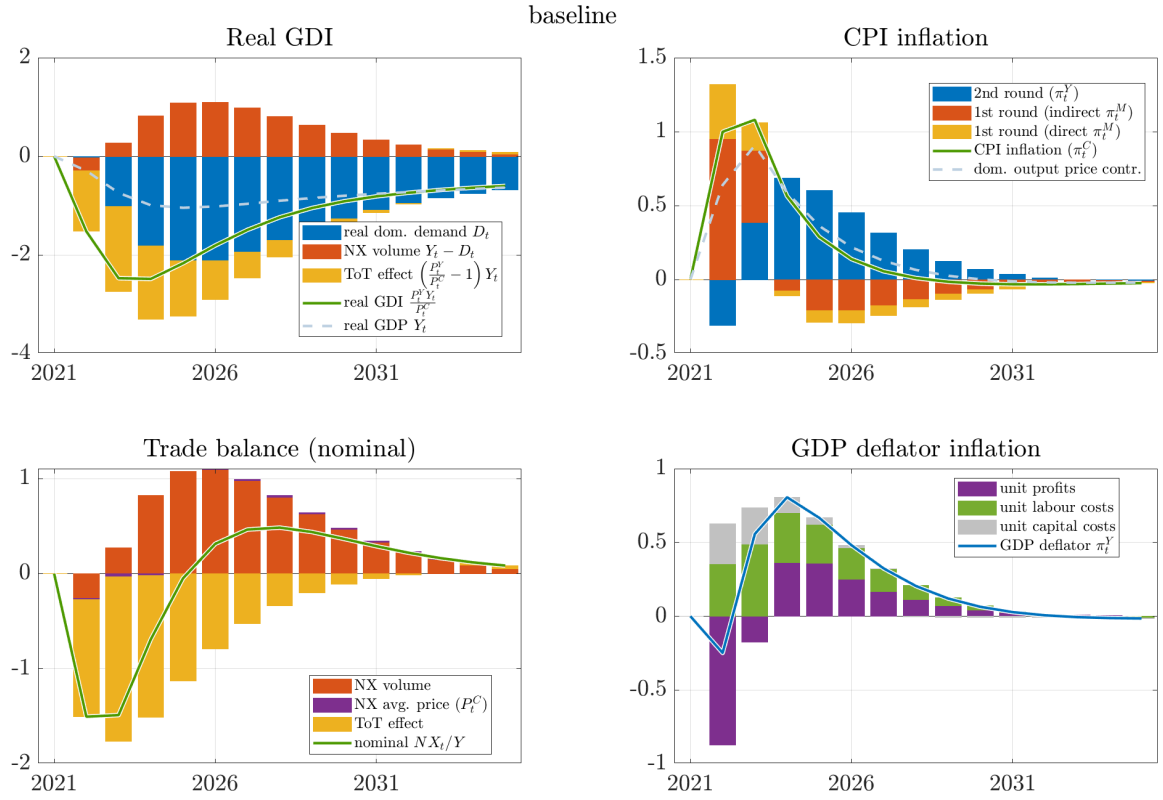
On the supply side, more expensive and imperfectly substitutable imported intermediate inputs raise marginal costs, acting as a cost-push shock, and encouraging domestic firms to scale back production. As Chan et al (2023) show, the strength of this channel depends on the degree of nominal rigidities and the elasticity of substitution between imported inputs and domestic factors of production ([6]). There is expenditure switching also on the supply side, which can constrain the rise in overall marginal costs by prompting firms to shift away from more expensive imported inputs towards relatively cheaper domestic ones, labour and capital. Therefore, even if gross *output* declines, real domestic *value added*, i.e. real GDP does not need to. But with relatively high complementarities in production, such substitution is not strong enough to avoid adverse supply side effects on GDP.

As a result of these demand and supply side forces, real GDP declines in our baseline simulations (see upper left panel of Graph I.1): expenditure switching effects (pulling net exports up) are not strong enough to offset the negative income effects stemming from the terms-of-trade loss, the demand-cooling effects of monetary tightening, and the detrimental effects of more costly complementary inputs on production.

([5]) Auclert, A., Monnery, H., Rognlie, M., & Straub, L. (2023). Managing an Energy Shock with Heterogeneous Agents: Fiscal and Monetary Policy. Mimeo - Harvard University.

([6]) Chan, J., Diz, S., & Kanngiesser, D. (2023). Energy Prices and Household Heterogeneity: Monetary Policy in a Gas-TANK. Bank of England Staff Working Paper, 2023(1041).

Graph I.1: **Macroeconomic effects of an adverse terms-of-trade shock**



Impulse responses to a series of unexpected adverse terms-of-trade shocks, simulated by a two-region version of the QUEST model, for the EU-27. The stylised shocks are calibrated such that CPI inflation rises by 1 percentage point in the first year. Real GDI and GDP are expressed as percentage deviations from their steady state, inflation indicators as percentage point deviation from steady state, while the nominal trade balance is in level deviations expressed as a percentage of steady state GDP. Bars depict contributions to those changes.

Source: European Commission staff calculations.

I.2.2. Second-round domestic price pressures

Following an adverse terms-of-trade shock, on top of the first-round effects of imported inflation, the economy also faces domestically generated price pressures, amid so called second round effects. These are captured by the price index for domestic value added, i.e. the GDP-deflator (see right panels of Graph I.1). To analyse fiscal indicators expressed as a share of nominal GDP, this is the relevant inflation measure, so it is important to understand its dynamics.

The price of domestic value added is an implicit residual, after subtracting the effect of imported input costs from final domestic output prices, with price setting for the latter subject to nominal rigidities. As such, the GDP-deflator is influenced by three counteracting forces ([7]):

- mechanical effect, due to the changing share of import costs in nominal output (-)
- aggregate demand effects, via domestic slack (-)

([7]) Note that often it is only the last force that is meant by "second round effects", but here we use that term more broadly, referring to domestic price pressures on top of (first round) imported inflation, as captured by the GDP deflator.

- attempt to recover real income loss ("wage-price spiral") (+)

To the extent that rising imported input prices do not perfectly pass through to sticky final output prices, the difference must be mechanically absorbed by a lower price of domestic value added. Depending on nominal rigidities, this manifests itself mainly in lower markups for domestic firms, pulling unit profits downwards (see bottom right panel of Graph I.1). However, rising import costs can also be absorbed by cheaper domestic production factors such as labour and capital (especially if complementarities with imported inputs are strong enough), lowering other components of the firm's marginal costs ([8]). Lower wages and capital rental rates would depress unit labour and capital costs, also pulling the GDP deflator downwards via this mechanical effect ([9]).

As we have seen, the adverse ToT shock lowers real GDP and weakens aggregate demand. Larger slack in the economy moderates domestically generated price pressures, as lower production levels imply lower real marginal costs for firms, mainly via softening wage requests from the labour supply side. This is the standard textbook mechanism in the New Keynesian Phillips Curve.

As discussed above, the terms-of-trade loss erodes the purchasing power of the domestic economy *as whole*, making it inevitably poorer as the real consumption value of what it collectively produces declines. Individual domestic agents might try to recover their real income losses, but they cannot *all* escape getting poorer, and at an aggregate level all they can do is shift purchasing power losses among themselves, without managing to raise aggregate real domestic income. In the process, however, this struggle between firms and workers might also fuel domestically generated price pressures, amid what is often referred to as "wage-price spirals", but what is perhaps best described as "wage-price persistence".

Firms would aim to rebuild their reduced markups (prompting them to raise prices), while workers would like to recover losses in the consumption value of their salaries (prompting them to ask for higher nominal wages). Higher wages then raise marginal costs for the firm further, bringing markups back down and fuelling more price increases – which in turn erode the real wage again, fuelling more wage inflation, and so on. This collective (and ultimately failed) attempt to offset aggregate purchasing power losses therefore leads to wage-price dynamics, where inflationary pressures increasingly come from domestic sources and stay persistent ([10]).

The final dynamics of the GDP deflator in our model simulations are the result of the balance of the three channels described above. As the right panels of Graph I.1 show, the mechanical downward effect of incomplete price pass-through and the price moderating effect of weak aggregate demand dominate

([8]) As the Discussion Paper version of this article shows in further sensitivity analyses, this specific pattern of income distribution after an adverse ToT shock (driving the bottom right panel of Graph I.1) is less robust to alternative specifications. E.g. sufficiently stronger complementarities of labour with imported inputs can lead to *rising* unit profits at the expense of unit labour costs. Non-linearities in nominal rigidities (e.g. more flexible prices in a high-inflation environment) might also lead to stronger pass-through supporting profits, and the recent "sellers' inflation" discussion also points towards markups being raised more easily in a high-inflation environment.

([9]) The decomposition of the GDP-deflator used here (and in the bottom right panel of Graph I.1) is somewhat different from other decompositions based on national accounts data. While the latter uses gross operating surplus for firms (profits in the accounting sense), our current approach splits this further into "pure" profits (resulting from market power and markups) and capital costs (that capture the maintenance and opportunity costs of holding physical capital stock).

([10]) Lorenzoni and Werning (2023) interpret the New Keynesian wage-price persistence mechanism fundamentally as a disagreement about the real wage between firms and workers, thereby pointing to a *distributional conflict* as the proximate cause of inflation. As Blanchard (1986) has shown, these inconsistent real wage targets can exist even under fully forward-looking rational expectations, as long as not all price and wage decisions are taken simultaneously – a feature of every New Keynesian model with staggered price (and/or wage) setting. Instead of reaching the new equilibrium real wage instantaneously, the process can be drawn out due to out-of-sync nominal rigidities (with its exact pattern depending on relative price and wage stickiness). See Lorenzoni, G., & Werning, I. (2023). Wage Price Spirals. *Brookings Papers on Economic Activity,* 54(2), and Blanchard, O. J. (1986). The Wage Price Spiral. The *Quarterly Journal of Economics*, 101(3), 543-566.

initially, and the GDP deflator actually *falls* in the first year of the shock ([11]). Later on however, the attempt by domestic agents to recover their real income losses becomes the main driver of domestic price pressures, fuelling positive second-round effects, even as first-round imported inflation subsides. Taken together with the decline in real GDP, the just discussed evolution of the GDP deflator implies that nominal GDP is lower in the first two years of the simulation and becomes higher only thereafter.

I.3. FISCAL EFFECTS OF ADVERSE TERMS-OF-TRADE SHOCKS

In our baseline simulations the primary budget balance declines as a share of GDP in response to an adverse ToT shock (Graph I.2, left panel). Importantly, the baseline scenario assumes no *discretionary* reaction from the side of fiscal policy in response to the cost-of-living crisis and the developing recession, nor in response to the increasing debt-to-GDP ratio ([12]), in order to isolate the effect of the shock from these fiscal decisions.

The widening primary deficit is driven mainly 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 on the primary balance by construction. These effects depend crucially on the indexation rules of expenditure items ([13]).

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. As the nominal wage distribution shifts into higher tax brackets that are not automatically adjusted in line with wage inflation, the average labour tax rate also increases, raising labour tax revenues as a share of GDP beyond what is implied by a higher labour income share. In addition, VAT revenues also rise because of the opening wedge between the CPI and GDP deflator, while consumption volumes are slower to moderate, so the government can collect taxes on relatively more expensive consumption goods. However, these positive revenue effects are not large enough to offset the effect of higher expenditures, so overall the primary deficit widens.

Overall, the terms-of-trade deterioration leads to an increase in the public debt-to-GDP ratio**.** The right panel of Graph I.2 decomposes the dynamics of the cumulative change in debt-to-GDP, according to the following equation ([14]):

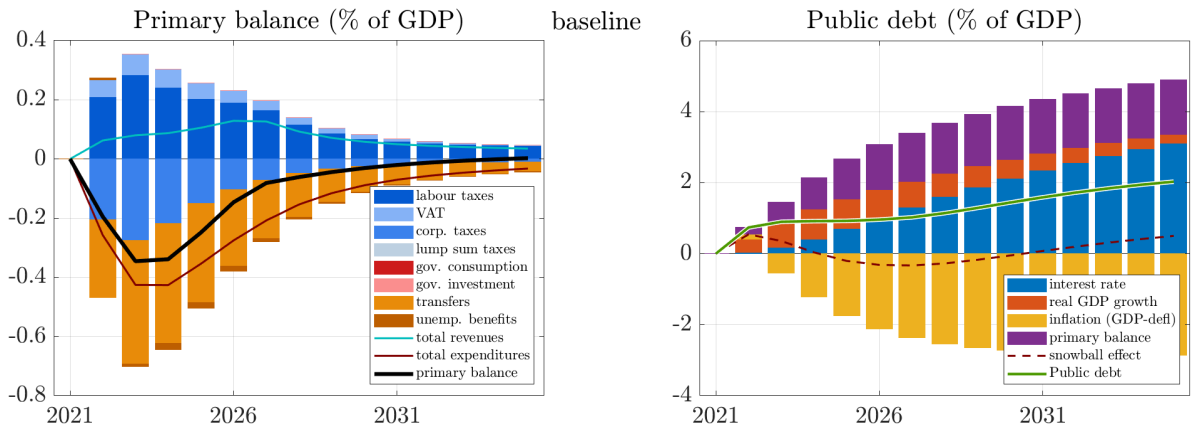
([11]) This baseline result of initially lower GDP deflator as a result of an adverse ToT shock is less robust to alternative monetary policy specifications. In Section I.4. we consider a delayed response from the central bank, under which the aggregate demand channel contributes more positively, resulting in rising GDP deflator already on impact.

([12]) In other words, the debt-stabilising motive in the fiscal rule, that would automatically raise primary balances in response to a rising public debt ratio, is switched off for the first 20 years of the simulation. Beyond this point, a debt stabilising *passive* fiscal rule is restored, in order to prevent conflict with an *active* inflation targeting monetary policy rule, thereby ensuring non-explosive stable model dynamics, amid a coordinated monetary-fiscal policy regime.

([13]) A sensitivity analysis in Section I.4., explores this further and shows alternative indexation rules.

([14]) The cumulative change in the public debt-to-GDP ratio is denoted by $\hat{d}_T$, while 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.

Graph I.2: **The fiscal effects of adverse terms-of-trade shocks**



Impulse responses to a series of unexpected terms-of-trade shocks, simulated by a version of the QUEST model, calibrated for the EU-27.

Source: European Commission staff calculations.

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

As the chart shows, the debt-reducing effect of (eventually) higher inflation is outweighed by the adverse effects of slower real growth, higher interest rates and a declining primary balance. Monetary tightening in response to higher CPI inflation via raising short term interest rates ([15]) 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. Rising real interest rates depress real economic growth further beyond the direct recessionary impact of the shock, while also mitigating the rise in inflation itself, all of which contribute to increase debt-to-GDP.

The so called "snowball effect" due to the interest-growth differential is the sum of the blue, red and yellow bars on the right panel of Graph I.2. As one can see, it never becomes too negative (initially even being positive) which is not what the debt-reducing effect of the inflation term alone would imply: higher nominal interest rates and lower real growth counterbalance that. In addition, recall that the relevant inflation measure here is GDP-deflator growth which, despite sharply increasing CPI inflation, builds up only gradually as second round effects on domestic prices gain strength later on.

That said, the snowball term is never too positive, either, which one might expect based on higher short term real interest rates and declining real growth. The reason for this is mainly long-term public debt, which can protect its issuer against rising short term interest rates, and at the same time impose losses from inflation revaluation on bondholders. Although monetary policy makes sure to raise *short term* real interest rate throughout the simulation horizon, the *effective* real interest rate for long term government debt can initially decline, as due to longer maturities the pass-through from higher short term nominal rates is only gradual, while the effect of higher inflation is felt more quickly. Therefore, in our baseline scenario "inflating away" the public debt, in the sense of negative effective real interest rates on

([15]) Monetary policy in QUEST responds to current deviations of CPI inflation from target and to a measure of the output gap (with additional interest-smoothing also applied). This policy rule is more lenient on supply-driven inflation deviations, to the extent that those result in a negative output gap, but the net effect is still an interest rate increase.

government bonds, does happen, even if only to a limited extent and for a contained period of time. It is just more than offset by slower real growth and a declining primary budget balance, such that the debt-to-GDP ratio is higher throughout the simulation.

I.4. ALTERNATIVE MONETARY-FISCAL POLICIES

Various features of economic policy can have major implications for how an adverse terms-of-trade shock affects debt dynamics, which are explored in this section.

I.4.1. Monetary policy and debt management

Monetary policy normalisation in the euro area triggered a discussion where some suggested the ECB and other EU central banks reacted too late to inflationary pressures, while others warned about the risks of too excessive monetary tightening. Reflecting these two views, we consider two alternative scenarios for monetary policy relative to our baseline policy rule. While in one of them monetary policy reacts more strongly to deviations from its inflation target ("stricter inflation targeting"), in the other the central bank is more accommodative, not responding immediately to inflationary pressures ("delayed response").

As we can see on Graph I.3, the results depend crucially on these policy settings. A more aggressive monetary tightening 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 raising the debt-to-GDP ratio above its baseline trajectory.

In contrast, with an initially unresponsive monetary policy the opposite happens, and results even change in qualitative terms, leading to an outright *fall* in public debt as a share of GDP. A more "dovish" monetary stance supports aggregate demand and real growth, and thereby also facilitates stronger domestic price pressures via second round effects, encouraging workers to try to recover more of their lost purchasing power via faster growing nominal wages. A more gradual monetary tightening also lowers the effective nominal interest rate on public debt, directly helping to keep interest payments in check. Together with higher inflation, this leads to a markedly negative effective *real* interest rate on bonds: the implicit fiscal consolidation behind the debt reduction is essentially paid for by levying an inflation tax on long term bondholders. That said, the response of the primary budget balance also flips sign and contributes to lower public debt. The main reasons behind this are that higher real GDP lowers the GDP share of expenditure items that are fixed in real terms (like transfers), and also that higher nominal wage growth increases the average labour tax rate in a progressive tax system due to the fiscal drag effect. This highlights the fact that in addition to leading to higher inflation (with its own welfare costs), this policy does not provide a free lunch in a narrower sense either, as debt reduction is essentially paid for by households ([16]).

This more accommodative scenario bears some resemblance to a *passive monetary policy* regime ([17]), whereby the central bank is not (very) responsive to inflationary pressures and the policy rule violates the Taylor principle, meaning that it raises interest rates less than one-for-one to rising inflation. This entails a drop in short term *ex post* real interest rates, such that inflation has the potential to stabilise

([16]) The delayed response strategy might also run the risk of de-anchoring inflation expectations, which would require more costly higher interest rates later on. This channel is present in our model only to the extent that inflation expectations are partially backward-looking, not fully anticipating future monetary policy actions.

([17]) Leeper, E. M. (1991). Equilibria Under “active” and “passive” monetary and fiscal policies. *Journal of Monetary Economics*, 27, 129–147.

even short term debt at the expense of bondholders. In contrast, recall that in our baseline scenario an *active monetary policy* (satisfying the Taylor principle) ensures to raise *short term* real interest rates, and the *effective* real interest rate for government debt can decline only due to long debt maturities: short-term debt could not be inflated away under such a regime, and rather taxpayers would have to raise primary budget surpluses in the future to stabilise public debt (passive fiscal policy).

That said, monetary policy remains ultimately active in all our simulations ([18]), but the "delayed response" scenario *temporarily* suspends the Taylor-principle by keeping the policy rate completely unresponsive for 5 quarters, bringing in some of the features of a passive monetary policy regime.

Turning to the role of debt maturities, the rather long weighted average maturity of outstanding government bonds might be a misleading indicator. The main reason for this is that past bond purchases by central banks (quantitative easing or QE) have shortened the duration of the *consolidated* government's liabilities (i.e. those of central banks and treasuries combined) ([19]). QE effectively swapped long-term government liabilities (bonds) for very short-term monetary liabilities (central bank reserves) in the hands of the private sector: while these long bonds still count towards average debt maturity indicators, they have in effect been bought back by the consolidated government, which issued very short-term liabilities in their stead. Another way to see how rising short term interest rates can impact the fiscal balance sooner than suggested by bond maturities, is to consider that QE has created a big maturity mismatch in the central bank's balance sheet, financing long assets with short liabilities. So as policy rates go up, this immediately leads to losses for taxpayer-owned central banks via rising interest costs on their short reserves, and thereby lowering seigniorage revenue for the government budget (or even requiring explicit recapitalisation from the treasury).

Therefore, the fiscal costs of monetary tightening via raising short term interest rates might materialise sooner than suggested by general government debt maturities, once we take into account the effect of past QE programs. While the central bank balance sheet is not modelled explicitly in QUEST, we can think of public debt in the model as that of the *consolidated* government (i.e. central bank and treasury combined) – instead of restricting it to *gross general* government debt. In other words, it is a kind of synthetic liability, a portfolio of long treasury bonds and short central bank reserves in the hands of the private sector. This motivates the alternative scenario with a shorter debt maturity of 2 years (instead of 7 years in the baseline case), that would thereby implicitly take into account the rising interest costs on central bank reserves ([20]).

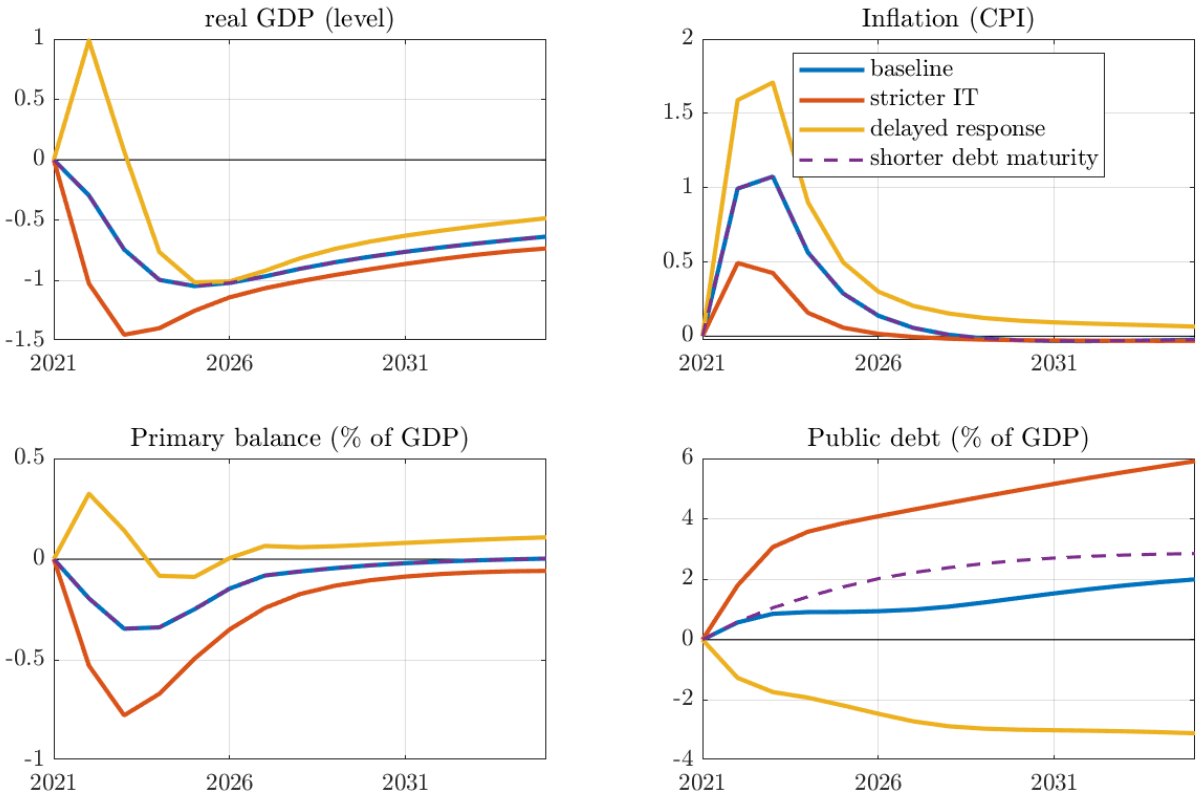
As shown on Graph I.3, shorter debt maturity would speed up the rise in debt-to-GDP ratios, as higher short-term rates would feed much quicker into effective debt financing costs. However, when the debt stabilisation motive in the fiscal rule is switched off (as is the case in the first 20 years of our simulation), this does not affect the primary budget balance, only interest payments. Therefore, without additional fiscal impulse, maturity length does not matter much for the wider macroeconomic effect of the shock either – but it is quite consequential for debt dynamics.

([18]) This is a necessary feature to pin down the price level and have a unique determinate equilibrium in the presence of an ultimately Ricardian passive fiscal rule that stabilises public debt via raising primary budget surpluses (in our scenarios the fiscal rule is switched on only after 20 years though).

([19]) Another reason is that average maturity is biased upwards by a few very long maturity bonds, such that the median ("interest-rate half life") is much shorter, which means that near term financing costs could increase faster than expected. *The Economist.* (2022). How higher interest rates will squeeze government budgets. 12 July 2022, https://www.economist.com/finance-and-economics/2022/07/12/how-higher-interest-rates-will-squeeze-government-budgets.

([20]) As a consequence of this modelling shortcut, the profit/loss of central banks is captured among debt service costs of the consolidated government instead of in the general government's primary balance. But apart from this, it should capture overall fiscal costs accurately.

Graph I.3: **Effects of an adverse terms-of-trade shock under alternative monetary policy settings**



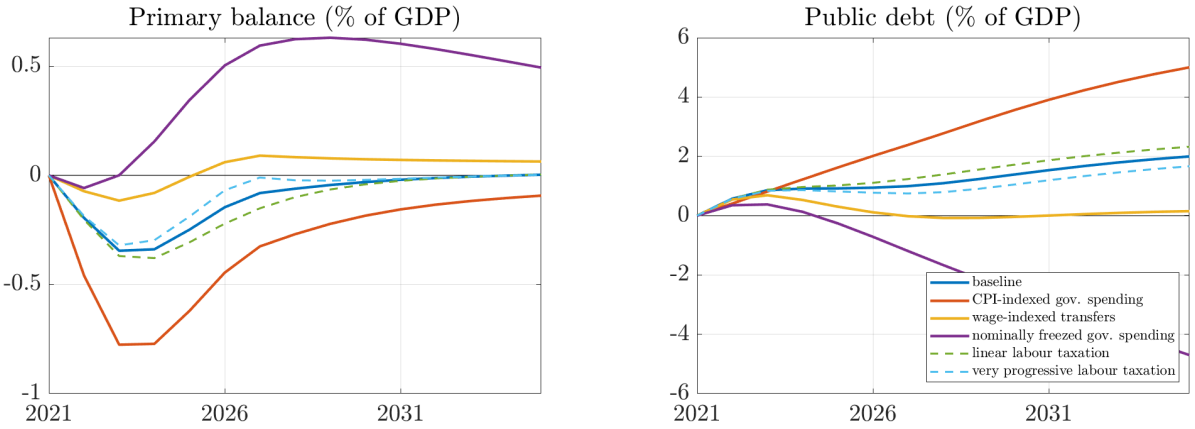
Impulse responses to a series of unexpected adverse terms-of-trade shocks, simulated by a version of the QUEST model, for the EU-27. The alternative scenario "stricter inflation targeting" features a Taylor rule with an inflation reaction coefficient of 3 instead of 1.2 in the baseline scenario. In the "delayed response" scenario monetary policy keeps interest rates fixed for the first 5 quarters following the shock. "Shorter debt maturity" features an average debt maturity of 2 years instead of 7.

Source: European Commission staff calculations.

To put this another way, by shortening the maturity of the consolidated government's debt vis-a-vis the private sector, QE has also limited the government's ability to erode the real value of its outstanding liabilities by surprise inflation (i.e. its capacity to "inflate away"). Those shortened liabilities are being repriced more quickly at the higher nominal interest rates brought about by rising inflation, thereby offsetting the beneficial effect of higher inflation within the snowball term to a larger extent (i.e. limiting to how low the ex post real effective government interest rate can fall) ([21]).

([21]) Of course, the central bank (a sub-branch of the government) could decide *not* to raise short-term nominal interest rates in response to rising inflation, thereby ensuring that real rates are falling for whatever maturities (a passive monetary policy rule, violating the Taylor principle). That is, coordinated joint monetary-fiscal policies always have the power to inflate away their paper liabilities, even if they have very short maturities. The delayed monetary response scenario discussed above goes some way towards such a policy mix, but only to a limited extent. A truly permanent passive monetary + active fiscal policy regime, however, is not considered in this paper.

Graph I.4: **Effects of an adverse terms-of-trade shock under alternative fiscal policy settings**



Impulse responses to a series of adverse terms-of-trade shocks, simulated by a version of the QUEST model, for the EU-27.

Source: European Commission staff calculations.

I.4.2. Fiscal policy

Recall that the baseline result of a widening primary deficit after a terms-of-trade deterioration was mainly driven by the assumption of transfers being indexed to rising consumer prices. To investigate the robustness of this result, we also explore alternative indexation assumptions concerning public expenditures like government consumption and investment (assumed to be fixed as a share of GDP in the baseline scenario), and transfers (assumed to be indexed to CPI in the baseline).

As we can see on Graph I.4, indexing government consumption and investment (beyond transfers) to rising CPI, 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 born 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 ([22]). Finally, 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).

The main takeaway from this exercise is that different expenditure indexation rules are highly consequential for debt dynamics. However, our baseline result that the debt-to-GDP ratio increases after an adverse terms-of-trade shock, seems fairly robust across most of these stylised scenarios. That said, to the extent that actual policy on the very short run is better characterised by non-immediate indexation, debt dynamics on this horizon might be described more accurately by our stylised scenario of a complete nominal freeze on public expenditures, where the associated benefit erosion could contribute to lower debt-to-GDP.

([22]) Note however that the primary balance initially declines 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. As explained in Section I.2.2., this is due to the only gradually developing second round price pressures, whereby imperfect pass-through of more expensive imported inputs to gross output prices, as well as the downward pressure on domestic prices stemming from weaker demand initially dominate the attempt of domestic workers and firms to recover their (CPI-deflated) real income losses. The GDP deflator starts to increase only later under our baseline monetary policy settings.

We also consider alternative fiscal settings on the revenue side. Recall that in our baseline scenario with a progressive labour tax system, the fiscal drag effect contributes to higher tax revenues and supports the primary balance (as the wage distribution shifts into higher, nominally fixed tax brackets, raising the average labour tax rate). 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 stronger. While this has some impact on households' disposable income, as Graph I.4 shows, in terms of debt dynamics it makes a much smaller quantitative difference than varying expenditure-indexation rules ([23]).

I.5. DIFFERENT INFLATIONARY SHOCKS

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 fact, a positive demand shock, with the *same* inflationary impact as the adverse ToT shock, would have qualitatively opposite fiscal effects (see Graph I.5) ([24]). 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 ([25]).

Graph I.5 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*), mainly due to depressing real output while also pushing inflation upwards, and inviting monetary tightening. 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. In particular, the evolution of the wedge between CPI and GDP-deflator and the strength of second round effects are quite different: the beneficial expenditure switching effects of a terms-of-trade deterioration are missing for the domestic supply shock, leading to an initially deeper fall in real GDP. But domestic prices (and thereby nominal GDP) initially rise more given the domestic trigger for inflation, after which they moderate more quickly as a directly suppressed labour share and larger labour market slack keep subsequent second round effects more in check. This makes for an initially smaller, but eventually larger rise in public debt compared to the terms-of-trade shock.

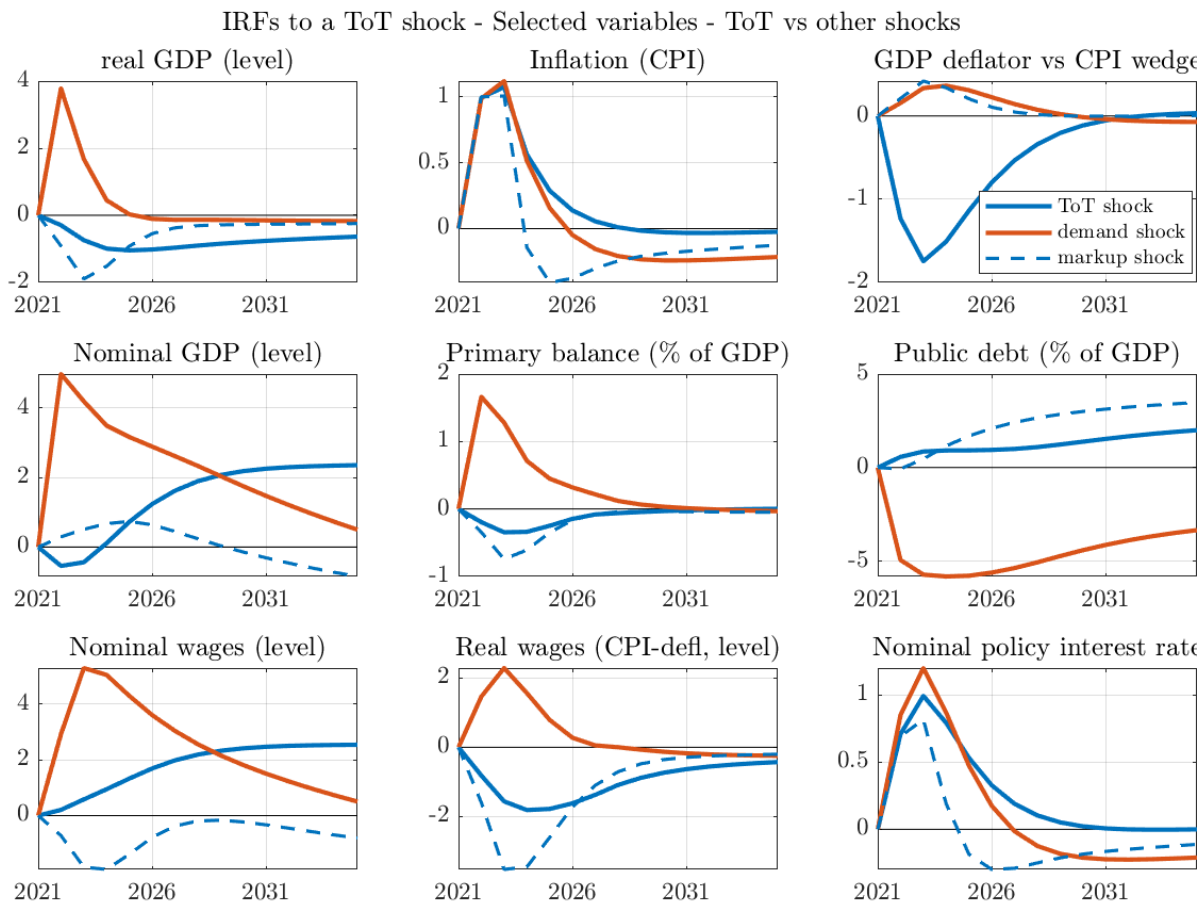
Inflation in Europe is likely driven by a combination of different types of shocks, so the relevant fiscal effects are most probably a mix of the clean scenarios discussed here. That said, the simulations presented here emphasise the importance of identifying the underlying sources of inflation for properly estimating the fiscal consequences.

([23]) 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.

([24]) 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), url. https://www.ecb.europa.eu/pub/economic-bulletin/articles/2023/html/ecb.ebart202302_01~2bd46eff8f.en.html.

([25]) 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.

Graph I.5: **The effects of different types of shocks**



Impulse responses to various shocks based on simulations by the QUEST model for the EU-27. All shocks are calibrated such that CPI inflation in the first year following the shock rises by 1 percentage points relative to the steady state.

Source: European Commission staff calculations.

While the intuition behind the advantageous effects of higher inflation on public finances is not necessarily wrong (as in the case of a positive demand shock), 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.

I.6. CONCLUDING REMARKS

This chapter investigated the general equilibrium fiscal implications of an adverse terms-of-trade shock. Despite the inflationary nature of such a shock, debt-to-GDP ratios tend to rise, as negative real growth effects due to a loss of domestic purchasing power and widening budget deficits offset the erosive effect of higher inflation, especially if monetary policy raises interest rates promptly and debt has short maturities.

That said, the simulations have also demonstrated how consequential policy settings can be. Under certain policy configurations public debt can indeed follow a lower trajectory, but this comes with some trade-offs and such alternative policies are no free lunch. The burden of the implicit fiscal consolidation behind stabilising the debt-to-GDP ratio is always born 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 higher unemployment and lower degree of fiscal income insurance associated with these policies might entail further welfare costs on their own right.

It is worth emphasising that, rather than deriving *optimal* policies along these complex trade-offs, the analysis in this chapter is strictly descriptive. It does not aim to suggest that rising debt ratios in the face of an adverse shock are undesirable from a normative aspect, nor that more inflationary monetary policies or more austere budgetary consolidation would be called for, just so that debt-to-GDP does not increase as much. In fact, far from being unambiguously bad, public debt can be a very useful tool in the hands of fiscal policy if it is not overused ([26]).

([26]) As Blanchard and Pisani-Ferry (2022) pointed out, it can be welfare-improving if fiscal policy fulfils an insurance role and supports the groups most exposed to real income losses amid the cost-of-living crisis – while monetary policy aims to keep second round domestic price pressures in check, without trying to suppress all of the first round impact. Blanchard, O., & Pisani-Ferry, J. (2022). Fiscal support and monetary vigilance: Economic policy implications of the Russia-Ukraine war for the European Union. *PIIE Policy Brief*, 2022(5). https://www.piie.com/sites/default/files/documents/pb22-5.pdf.