

Appendix: Bottlenecks: causes and macroeconomic implications

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A model-based approach to understanding bottlenecks

This Annex describes simulations from a stylised macroeconomic model that incorporates simplified input-output relationships. The model is used to construct the simulations featured in Graph 3 in the accompanying Bulletin, but can be used more generally to shed light on why bottlenecks have emerged in the recovery from the Covid recession and on their possible resolution.

The simulations rely on a multi-sector macroeconomic model (Rees (2021)). The model incorporates the standard nominal and real frictions (eg sticky prices and adjustment costs) typically included in macroeconomic models. It also features a detailed set of industry relationships on the demand side (allowing for substitution between industries in consumption and investment) and on the supply side (allowing for spillovers through input-output linkages).¹ It is therefore well suited to elucidating the economy-wide implications of bottlenecks in specific industries. The simulations use a version of the model calibrated to match the input-output structure of the US economy.

The Covid recession, and subsequent recovery, have seen a shift in the composition of demand away from services towards goods. To explore the implications, the first simulation assumes a permanent increase in households' preference for manufactured goods offset by a decrease in their preference for all other goods and services.² Because it takes time for firms to adjust their productive capacity, this shift has significant implications for aggregate economic activity, relative prices and inflation.

An increase in relative demand for manufactured goods has multiple effects. It naturally prompts an increase in their supply by raising relative prices. But it also has substantial spillovers, for two reasons (Graph A.1, red lines). First, the production of manufactured goods requires inputs of other items such as raw materials and transport services. This raises the demand for these items and, in the short run, leads to bottlenecks for some. Second, manufactured goods production is relatively capital-intensive. Hence, a persistent shift in production towards goods increases aggregate investment in the short run.

These positive spillovers to other industries reflect the specific characteristics of manufacturing production. Shifts in consumer preferences towards other industries can induce negative spillovers. For example, a shift in consumer preferences towards recreation services – which tend to be labour-intensive and require relative few intermediate inputs from other industries – reduce aggregate investment and output in other industries (Graph A.1, blue lines).

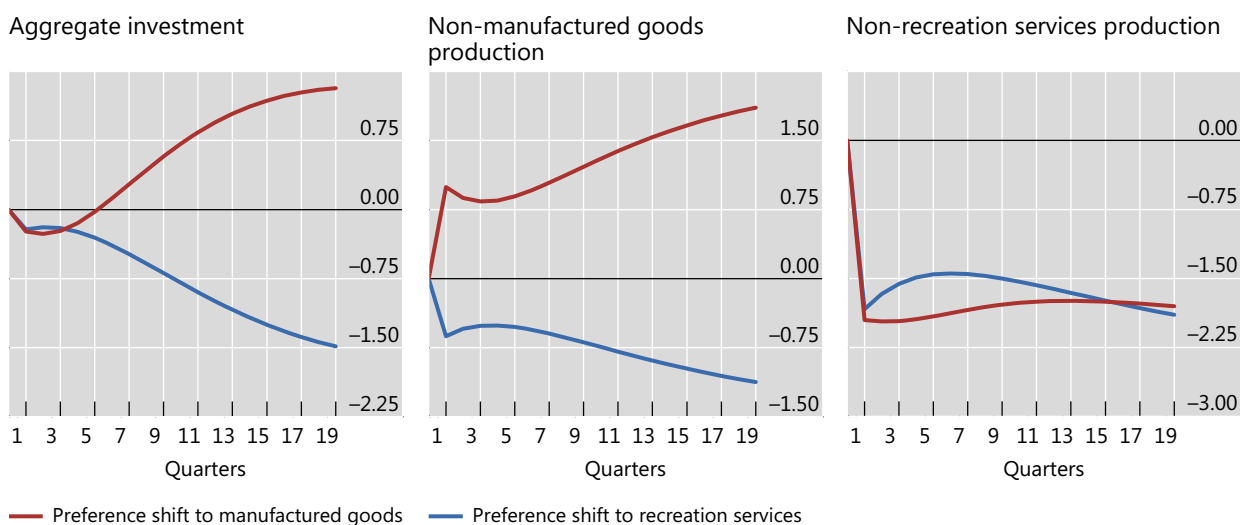
¹ The model features 13 industries, roughly corresponding to the ISIC 1-digit level of aggregation. Examples of industries include manufacturing, construction and retail trade.

² Because this is a pure preference shift across industries, it would have no effects on aggregate demand if labour and capital were perfectly substitutable across industries and prices and wages were flexible.

Shift in demand preferences to manufactured goods boosts investment and intermediate input demand

In per cent

Graph A.1



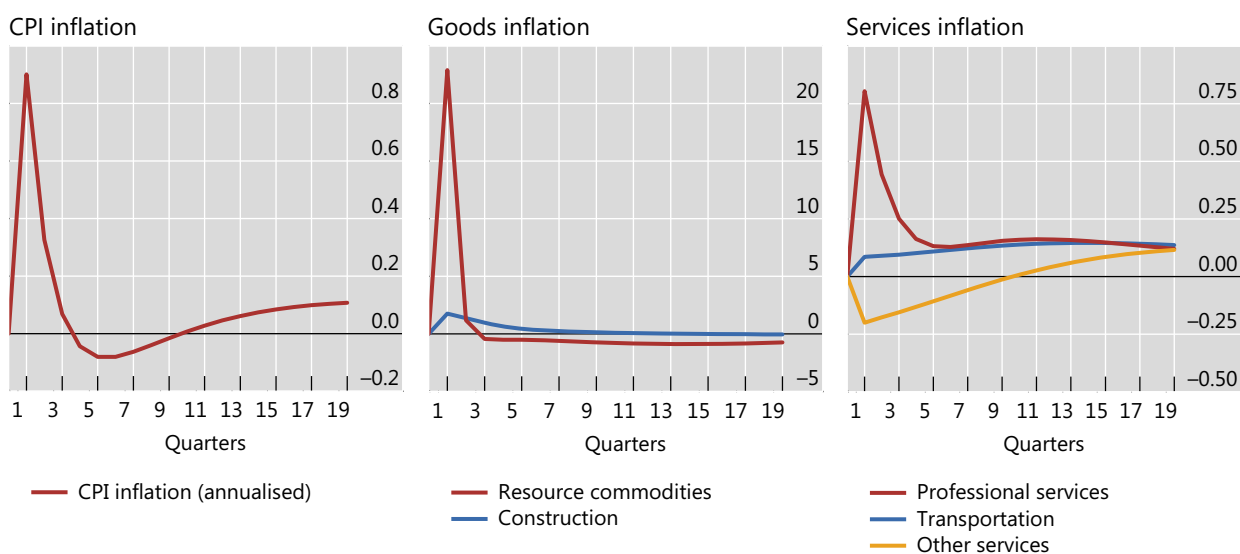
Source: BIS calculations.

A shift in consumption patterns towards manufactured goods is inflationary (Graph A.2, left-hand panel)). There are two reasons for this. The first relates to the aggregate demand effects described above. Increasing the production of manufactured goods also increases the demand for other items, including those needed to boost aggregate investment (centre and right-hand panels). The second is that goods prices tend to be relatively more flexible than services prices.³ Hence, the inflationary effects on goods prices more than offset the disinflationary effect of lower demand for services.

Shift in demand preferences towards manufactured goods is inflationary

In percentage points

Graph A.2



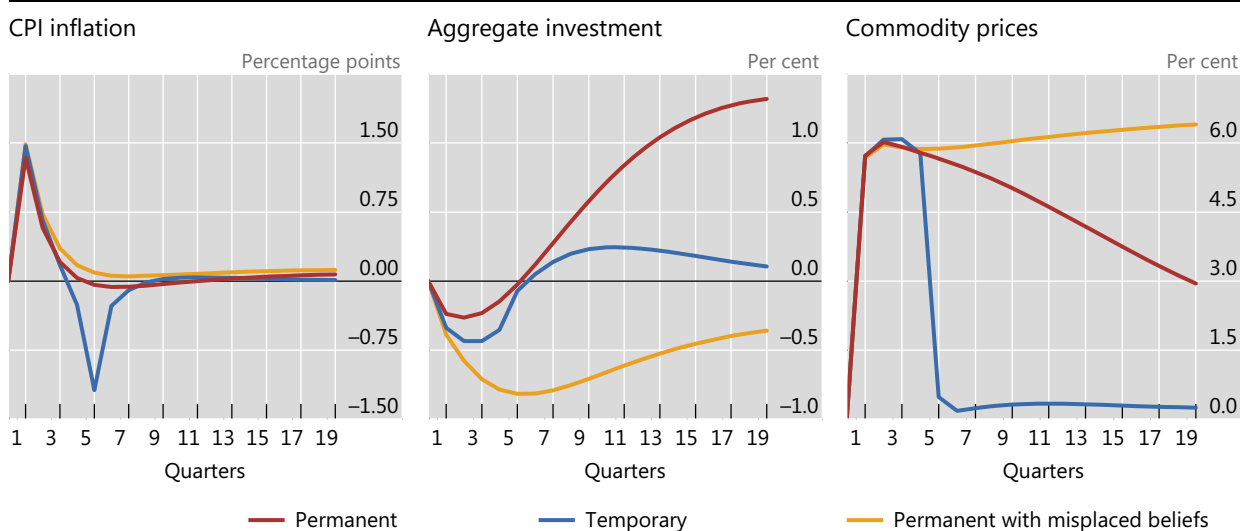
Source: BIS calculations.

³ See Eusepi et al (2011).

The duration of bottlenecks and extent of their inflationary effects depend on the persistence of their underlying drivers and firms' expectations about this persistence. To illustrate this, consider two additional scenarios (Graph A.3). In the first, the shift in demand lasts for only four quarters, and firms correctly anticipate the duration. In the second, firms *expect* the change in preferences to be temporary, even though it turns out to be permanent.⁴ If the increase in relative goods demand is temporary, bottlenecks naturally ease when demand patterns return to normal (blue lines). The resulting fall in price for items affected by bottlenecks (like resource commodities) lowers aggregate inflation. In contrast, if the shift in preferences turns out to be permanent, even though firms expect it to be temporary, additional investment to expand the productive capacity of bottleneck-affected sectors may not take place (yellow). In this case, bottlenecks are likely to persist for longer and may even intensify, as shown in this example by resource commodity prices staying high.

Impact and persistence of bottlenecks depends on firms' expectations

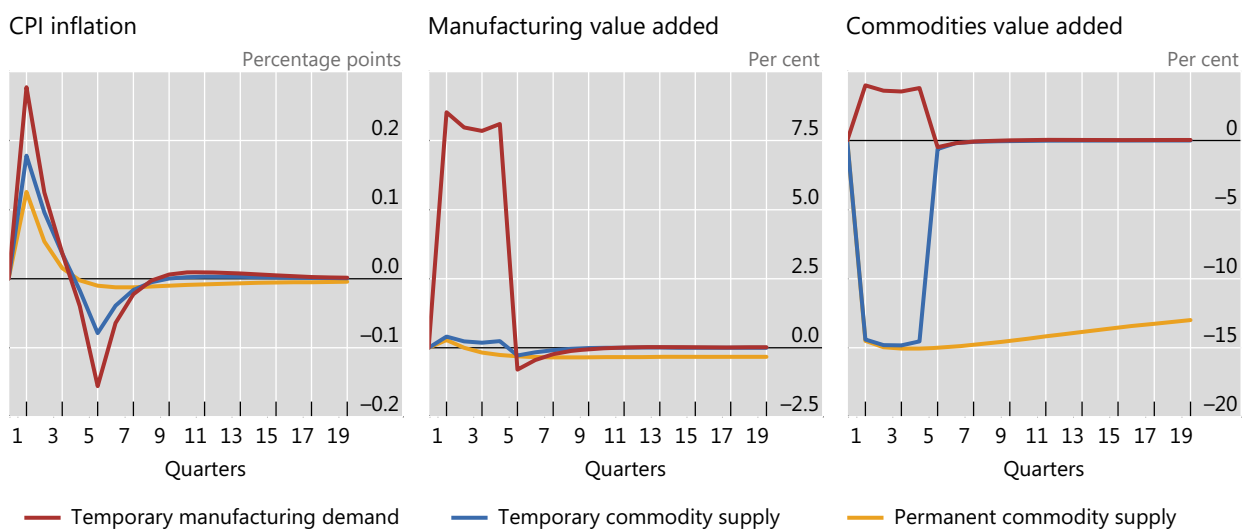
Graph A.3



Source: BIS calculations.

The implications of bottlenecks driven by supply disruptions, and their resolution, can differ from those of bottlenecks driven by stronger demand. Graph A.4 compares the implications of a temporary increase in the relative demand for manufactured goods (red lines) to a temporary (blue lines) and permanent (yellow lines) contraction in the supply of resource commodities that feed into the production of manufacturing goods. All three scenarios cause a bottleneck in resource commodity production, an increase in commodity prices and a pickup in inflation. But when supply disruptions are the cause, the production of commodity declines rather than increases. The production of manufactured goods stays relatively stable, because the model assumes that manufacturing firms can substitute additional labour, capital and other intermediate goods to make up for lower commodity supply. In reality, firms may be less able to substitute in this way (eg due to a need for specialised items), resulting in a larger contraction in manufactured goods production.

⁴ Specifically, at each point in time households and firms expect the demand shift to last for an additional four quarters. This approach to modelling the structural change incorporating misplaced beliefs follows Kulish and Pagan (2017).



Source: BIS calculations.

References

Eusepi, S, B Hobijn and A Tambalotti (2011): "CONDI: A Cost-of-Nominal Distortions Index", *American Economic Journal: Macroeconomics*, vol 3, no 3, pp 53–91.

Kulish, M and A Pagan (2017): "Estimation and solution of models with expectations and structural changes", *Journal of Applied Econometrics*, vol 32, no 2, pp 255–74.

Rees, D (2021): "What comes next?", *BIS Working Papers*, no 898.