Discussant remarks by Benjamin Beckers[1] on 'Decomposing Supply and Demand Driven Inflation' by Adam Shapiro

It's a great privilege to be asked to discuss Adam's thought-provoking paper which has been very helpful to inform our thinking about the demand- and supply-pressures driving inflation here in Australia over the recent period.

The proposition of the paper is – at its core – quite simple: If we accept that supply curves are upward-sloping and demand curves are downward-sloping, we can label inflation in each expenditure category of a price index as either supply- or demand-driven based on signs of the *unexpected* changes in their prices and quantities.[2] Using the index's expenditure weights, we can then aggregate up each of these component-level inflation rates separately for the demand- and supply-driven components and arrive at a measure of total supply- or demand-driven inflation.

Given the sharp rise in inflation that motivated Adam's work for the US, this paper was not only replicated widely across advanced economies but also by me and my colleagues for Australia.[3]

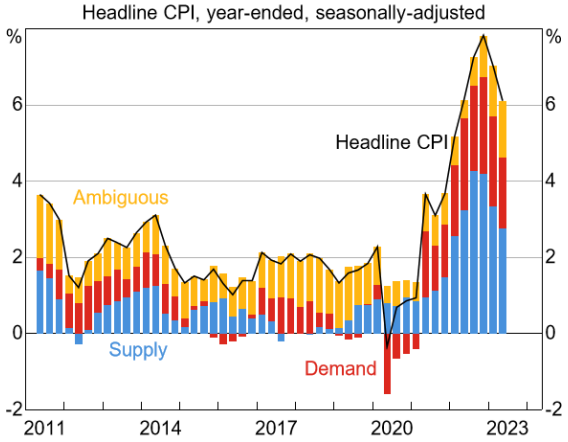
The Australian perspective

Applying Adam's method to estimate the contribution of demand and supply shocks to headline consumer price inflation in Australia reveals a similar story here. From early 2022, most of inflation appears to have been driven by supply shocks (Graph 1). At its peak in December 2022, supply-side factors contributed just over half (4¼ percentage points) to total headline inflation. But demand-side factors are also found to have been important and were responsible for around one-third of headline inflation. Around one percentage point of inflation remained unclassified or 'ambiguous' because either price or quantity changes were small relative to the uncertainty around these estimates.

Graph 1

Decomposition of Inflation*

Headline CPI, year-ended, seasonally-adjusted



* Based on the methodology of Shapiro (2022); 'Ambiguous' indicates the contribution from components where the unexpected change in prices or quantities is within the 25 per cent prediction interval and the contribution from unmodelled components due to data limitations.

Sources: ABS; RBA.

[1] Manager, Households, Business and Credit, Financial Stability Department. I want to thank my colleagues Matthew Read, Jonathan Hambur, Thomas Williams, Anthony Brassil and Anirudh Yadav on whose work I am drawing on in this discussion.

[2] The focus on *unexpected* changes is to abstract from deterministic movements in prices and quantities, such as the fact that prices and quantities tend to grow over time as the economy expands, or that prices for some goods respond slowly to (past) shocks.

[3] See Beckers, Hambur and Williams (2023) for the replication of Adam's work for Australia and a comparison to other approaches that I will discuss in these comments. See Adjemian, Li and Jo (2023), Chen and Tombe (2023), Gonçalves and Koester (2022) and Firat and Hao (2023) for other international applications of Adam's paper.

Some caveats of the method

But as with any empirical approach it is important to be aware of its caveats and the key assumptions that are underlying the analysis. In my remarks, I want to touch on one caveat I encountered when replicating Adam's work for Australia, and two general remarks on the approach, before closing by discussing what these imply for how central banks could use this approach and other models when facing uncertainty around the factors that are driving a sharp rise in inflation.

1. Forecast errors occasionally tell a different story about what is driving inflation

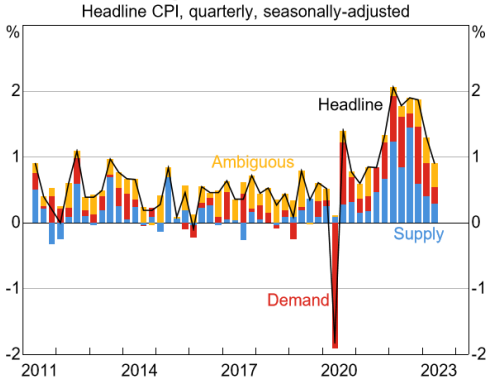
Because prices often respond slowly to shocks, inflation in any quarter is likely to be driven to a substantial degree by deterministic factors and past shocks rather than by new shocks only. For this reason, Adam proposes to estimate bivariate VAR models for prices and quantities of each expenditure category and assign supply and demand shock labels to expenditure categories based on the *unexpected changes* in prices or quantities. But Adam's decomposition of headline inflation then assigns *all of the inflation outcome* in an expenditure class to being supply- or demand-driven even though identification of the underlying shocks is based on the signs of the *forecast errors* from the underlying VARs alone.

In my replication of Adam's work to Australia I found that this distinction can matter. To show this, I compare the decomposition of Australian headline CPI inflation on a *quarterly* basis (Graph 2) with a decomposition of quarterly forecast errors underlying that decomposition of headline inflation (Graph 3).[4] Graph 2 shows the two large demand shocks that occurred when the Covid-19 pandemic arrived in Australia and then the substantial ramp up in supply-driven inflation over late 2021 and 2022.

Graph 2

Decomposition of Inflation*

Headline CPI, quarterly, seasonally-adjusted



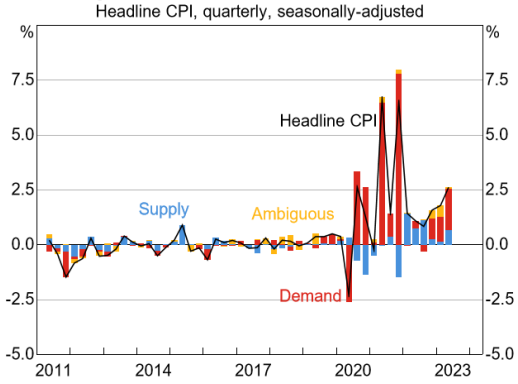
* Based on the methodology of Shapiro (2022); 'Ambiguous' indicates the contribution from components where the unexpected change in prices or quantities is within the 25 per cent prediction interval and the contribution from unmodelled components due to data limitations.

Sources: ABS; RBA.

Graph 3

Decomposition of Inflation Forecast Errors*

Headline CPI, quarterly, seasonally-adjusted



* Bottom-up one-quarter-ahead forecast errors split into contributions from supply- and demand-driven components weighted by expenditure shares. 'Ambiguous' indicates the contribution from components for which inflation or quantity forecast errors are within the 25 per cent prediction interval. Excludes large forecast errors for 'Other' category (~6% of CPI basket) for 2021:Q2, 2021:Q4, 2022:Q1.

Sources: ABS; RBA.

However, these results change markedly when I instead plot a decomposition of the inflation *forecast errors* from the underlying category-level VARs (Graph 3). In this case, demand shocks appear to be much more important in driving inflation surprises over the entire course of the pandemic, and – at least over 2020 and 2021 – the sign of supply shocks suggests that *positive* supply shocks drove *down*

[4] Adam defines supply-driven inflation as $\pi^{sup}_{t,t-1} = \sum_i \mathrm{I}^{sup}_{i\in sup,t}\omega_{i,t-1}\pi_{i,t,t-1}$, where $\omega_{i,t-1}$ is the expenditure weight and $\mathrm{I}^{sup}_{i\in sup,t}$ is an indicator function that takes the value of 1 if expenditure category i is supply-driven. I aggregate the contribution of supply-driven forecast errors to the aggregate bottom-up inflation forecast error as $u^{sup}_{t,t-1} = \sum_i \mathrm{I}^{sup}_{i\in sup,t}\omega_{i,t-1}u^{p}_{i,t,t-1}$ where $u^{p}_{i,t,t-1}$ is inflation forecast error for category i in period t.

inflation over that time. This demonstrates that the decomposition – at times – could be misleading for two reasons:

1. If the forecast error and the actual component-level inflation outcome are of opposite signs, the direction of the underlying shock can be different to what the aggregation might suggest.[5]
2. Inflation in any given quarter can be driven by deterministic factors to a large extent, including *past* demand and supply shocks. Taking Graph 3 at face value could mean that the 2022 inflation outbreak was, in fact, due to large positive demand shocks over 2020 and 2021, consistent with strong fiscal and monetary policy stimulus. However, it is important to note that this decomposition does not trace through the effect of such past shocks to future inflation outcomes; if large forecast errors occurred for components with very low persistence, their contribution to actual inflation over 2022 might have been small.

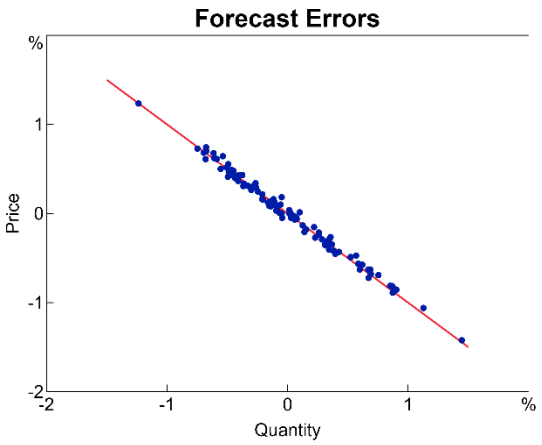
2. What can we learn from reduced-form errors about structural shocks?

In addition – and as emphasised by Adam in his paper – the approach assigns the entirety of a price change in a quarter to either a supply- or a demand-shock, depending on which shock is 'dominant' as indicated by the signs of the price and quantity forecast errors. However, in reality, both of these types of shocks are likely occurring simultaneously for each category. An approach that can explicitly deal with this simultaneity and the issues highlighted above is a structural VAR. This approach would therefore allow for both types of shocks to drive price changes in each expenditure category in a given quarter, and it would also allow to use historical decompositions of inflation outcomes in each expenditure category based on the history of structural shocks that occurred.

But before estimating a set of structural VARs for each expenditure category, it is useful is to think about under which conditions we can learn something meaningful from the reduced-form forecast errors about the structural shocks driving them. And fortunately, I can rely on the work of my colleague Matt Read (2023) here.

Let's consider an illustrative example: Assume the price and quantity forecast errors for a given expenditure category were negatively correlated as shown Graph 4, tracing out the demand curve. In this case, we could be confident that inflation in this expenditure category had mostly been driven by supply shocks, shifting prices (and quantities) up and down along the demand curve. The opposite would be the case if the price and quantity forecast errors were perfectly *positively* correlated, in which case they would trace out the supply curve and we could be confident that demand shocks had been driving inflation in this category.

Graph 4

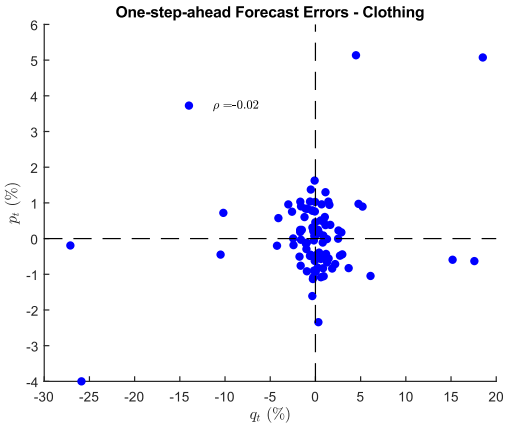


Unfortunately, however, such strong (negative or positive) correlations are rare in practice. For example, price and quantity forecast errors for clothing are almost entirely uncorrelated (Graph 5) – a picture that is quite representative for most expenditure categories for Australia. On the other hand,

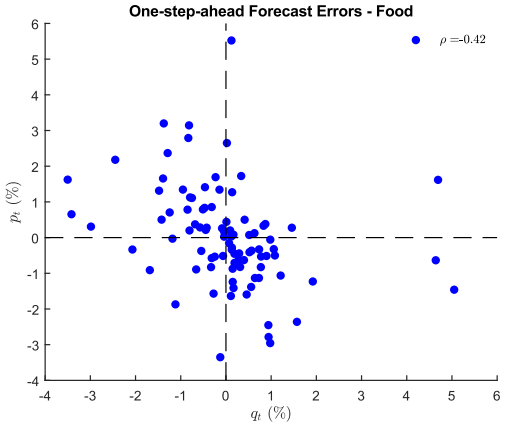
[5] E.g. if $u^p_{i,t,t-1} < 0$, $u^p_{i,t,t-1} > 0$ but $\pi_{i,t,t-1} > 0$ the aggregation will suggest that a supply shock in expenditure category i is contributing positively to aggregate inflation despite the model implying that a disinflationary supply shock occurred in that category.

one category that is more strongly negatively correlated is food which is consistent with our understanding that food prices are more often being driven by supply shocks (Graph 6).

Graph 5

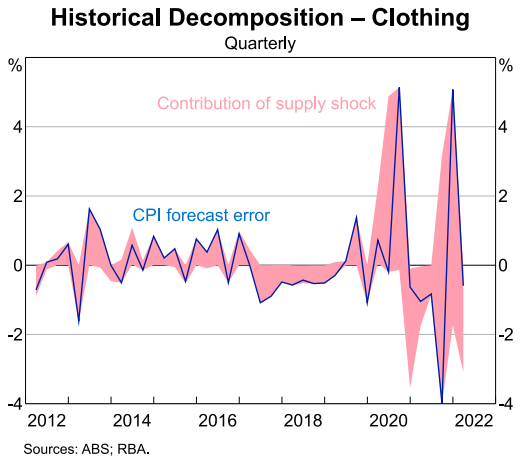


Graph 6

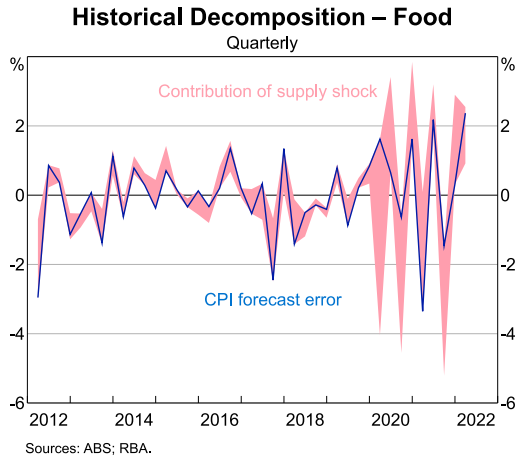


These correlations matter for the extent to which contributions of demand or supply shocks to inflation in each expenditure category can be identified using the sign restrictions used by Adam's method. Graph 7 and Graph 8 show the sets of historical decompositions from structural VARs identified using sign restrictions on the impact of demand and supply shocks on prices and quantities for clothing and food, respectively (Read 2023). Consistent with the above correlations, the historical decomposition is uninformative about the drivers of clothing inflation with supply shocks explaining between nothing and all of the forecast errors in clothing inflation at all times. In contrast, for food inflation, the stronger, negative correlation seems to allow to pin down the contribution of supply shocks with a bit more certainty (at least in some periods).

Graph 7



Graph 8



These findings raise questions whether the sign restrictions imposed by Adam's paper are sufficient to pin down the contributions of supply and demand shocks to inflation with high confidence. And while this may be an Australian-specific issue, it would be useful to explore further under what conditions the sign restrictions imposed by the assumptions about the slopes of the demand and supply curves can help to pin down the contribution of these shocks, something my colleague Matt Read is investigating further.

3. What are supply- and demand-shocks for a given expenditure category?

But even if a set of structural VARs would deliver narrowly-identified historical decompositions of the supply- and demand-drivers of inflation for each expenditure category, two further challenges remain:

1. Demand and supply shocks are loosely defined categories and include many very distinct underlying driving forces with different properties and implications for policy. For instance, demand shocks could be shocks to fiscal or monetary policy, or changes to households' preferences, and supply shocks could be shocks to technology, mark-ups or cost-push shocks. To assess what policy response is appropriate, further analysis may be necessary to identify the underlying fundamental driver.
2. Spillovers between expenditure categories are highly likely and common shocks could look like supply or demand shocks for individual categories. For instead, increased demand for groceries during COVID could really be the substitution response to a supply shock, namely lockdowns of restaurants. Or if fiscal policy increased spending on output from one sector, this could re-allocate labour or other inputs away from other sectors, thereby appearing like a demand shock to the first sector and a supply shock to other sectors. As a result, it not is not immediately clear that if we were to label an expenditure category as supply- or demand-driven, the underlying shock was indeed a supply or demand shock to that sector.

What does this mean for monetary policy?

This leaves me to ask what we (as central bankers) can do given these uncertainties?

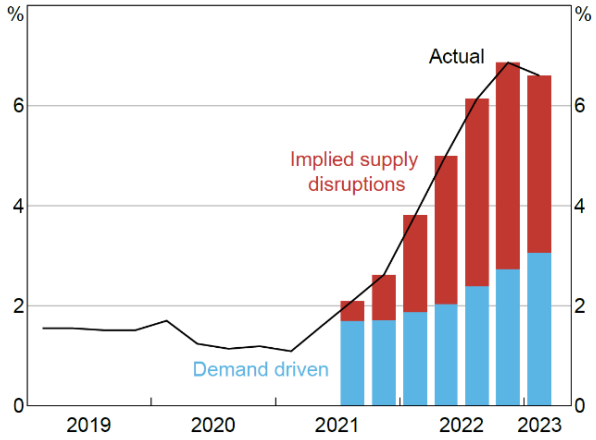
First, we can try to corroborate the results from Adam's work using other models, including models that place more structure on the underlying economic relationships. And two models broadly support the insights we gained from Adam's model. The Reserve Bank's Phillips Curve model – which is a simple univariate equation explaining inflation by a set of demand-side factors – also suggests that supply-side disruptions explained slightly more than half of core inflation around its peak (Graph 9). Whereas the Reserve Bank's DSGE model attributes a slightly larger share of around ¾ of peak inflation to supply shocks (Graph 10).[6] But broadly speaking, together with Adam's model and narrative information including from the Bank's liaison program, these results give us some confidence that supply shocks were indeed important drivers of inflation after the pandemic.

[6] See Beckers, Hambur and Williams (2023) for more detail on these two approaches.

Graph 9

Decomposition of Inflation – Approach 2

Trimmed mean, year-ended

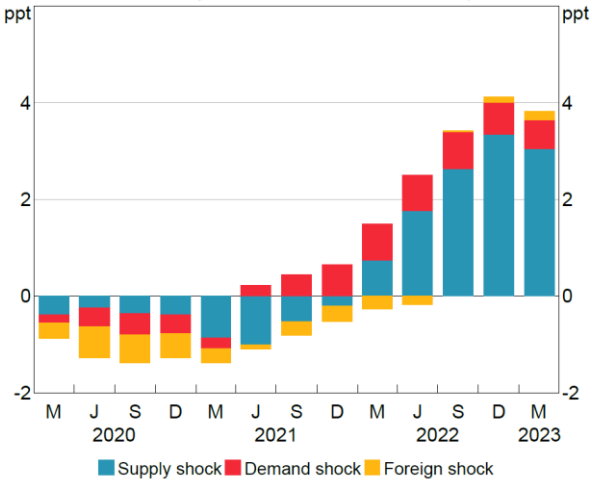


Sources: ABS; RBA.

Graph 10

Decomposition of Inflation – Approach 3*

Trimmed mean, year-ended, deviation from 2.5 per cent



* Demand includes monetary policy, investment and consumption shocks. Foreign includes foreign demand and cost shocks. Supply includes markup, technology and labour supply shocks. Supply will capture some overseas cost shocks.

Source: RBA.

Second and lastly, it is worth asking two 'what if's'. What if we didn't know what was driving inflation and what if all of inflation was indeed driven by supply-side factors? What would this mean for setting monetary policy?

And here, two lessons from the literature are worth repeating and generally support the decisive policy action taken by central banks over the recent inflationary episode:

1. Conventional wisdom suggests that central banks should 'look through' some *temporary* supply shocks (in particular: cost-push shocks).[7] But this wisdom does not necessarily apply if these shocks are persistent or when households or firms are backward-looking when forming their inflation expectations. In these cases, the literature emphasises that it is important to respond aggressively to any outbreak of inflation to avoid that high inflation is getting entrenched in expectations – irrespective of the shock that is driving inflation.[8]
2. Relatedly, when faced with uncertainty about the source or nature of the inflationary shock, the literature suggests using 'uncertainty robust' policy, which in this case implies responding more aggressively to prevent high inflation from becoming entrenched.[9] The more uncertain we are about what is driving inflation, the stronger is the case to use such 'robust control' methods. These methods can be thought as 'taking out insurance' against the largest possible welfare loss – which in this case would arguably be that inflation expectations became de-anchored.

[7] Gopinath (2022) and Schnabel (2022) summarise the case for looking through these shocks.

[8] See Orphanides and Williams (2003).

9 See Tetlow and von zur Muehlen (2001), Onatski A and JH Stock (2002), Söderström (2002), Coenen (2007), Giannoni (2007), Orphanides and Williams (2007), and Tetlow (2018).

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