Comments by Şebnem Kalemli-Özcan

The paper by Amiti, Heise, Karahan, and Şahin quantifies drivers of the U.S. inflation during 2021. They write down a model to explain the almost 4 percentage point increase in core CPI inflation from 1.6% in December 2020 to 5.5.% in December 2021. In order to allow for the peculiarities of the COVID-era inflation, they enrich an otherwise standard two-sector DSGE model with exogenous supply shocks coming from higher import prices, lower foreign competition and higher dis-utility of labor. They further add a reallocation shock where consumption shifts from services to goods. On top of all these exogenous shocks, they also factor-in the "no-response" monetary policy of 2021, keeping monetary policy accommodative. This effectively introduces a negative monetary policy shock. All the shocks (supply and reallocation of consumption) fully account for the 3.9 percentage points rise in core CPI inflation. The accommodative monetary policy helped the surge in inflation and hence all the shocks together over-explain the observed rise in inflation. Put it differently, model shows that tight monetary policy in 2021 would have crushed the over-recovery in the labor market.

The key intuition comes from the weak adjustment in relative prices due to a multitude of shocks, where each shock interacts with each other and amplifies each other's effect. For example, consumption of traded goods increased exactly at the time their shipping costs went up. Such amplification can be quantified given the non-linear solution. They feed deterministic shocks into a stochastic model and use second-order approximation to capture the non-linear effects.

This is a general interest paper on an important topic that has been widely debated since 2021. The following two facts indicate that the debate will continue for some time: (1) It is not only the U.S. but also all the other advanced countries are going through the highest inflationary episode of the last four decades, and (2) none of these countries have brought the inflation back to their targets.

The paper is part of a growing literature that links inflation to factor prices and labor market in global networks/multi-sectors and in non-linear closed/open economy models.[1] Similar to di Giovanni, Kalemli-Özcan, Silva, and Yıldırım (2022) they abstract from energy/oil shocks and focus on core inflation in 2021 to focus on the "sectoral" supply shocks that were the dominant drivers of inflation early on in 2021. This also allows them to quantify, exactly as in di Giovanni, Kalemli-Özcan, Silva, and Yıldırım (2022), the amplification effect of supply disruptions due to consumption shift between sectors. Differently than di Giovanni, Kalemli-Özcan, Silva, and Yıldırım (2022) and the existing literature on this topic that works with multi-sectors and networks, all the foreign shocks including price shocks are exogenous to the U.S. even U.S. is not a small open economy and shocks are global. When labor does not want to work and imported inputs are expensive, substitution from imported inputs to labor cannot smooth the inflationary impact of the foreign price shock. This happens since domestic firms increase markups without losing market share to foreign competition as foreigners also got hit by the same shocks.

I will organize my comments in three groups. First, I discuss the suitability of the modeling features to the facts of the last three years. Second, I discuss the pros and cons of the paper's methodology, running impulse responses by feeding shocks to the model, instead of estimating the model, and doing a full variance decomposition on inflation drivers. Finally, I evaluate the key role of certain parameters, such as the elasticities governing substitution between labor and domestic inputs and between domestic and foreign inputs, on the quantitative implications of the model.

The model has many shocks. This might be needed to match the real life COVID-era characterized by a multitude of shocks. However, assuming all these shocks to be exogenous, sets the deck against monetary policy being helpful. Higher dis-utility of labor (lower labor supply) and higher foreign prices are partly endogenous responses to generous fiscal stimulus

[1] See La'O and Tahbaz-Salehi (2022), Baqaee and Farhi (2022), Guerrieri, Lorenzoni, Straub, and Werning (2022), Woodford (2022), Afrouzi and Bhattarai (2023), Pasten, Schoenle, and Weber (2020), Ferrante, Graves, and Iacoviello (2023), di Giovanni, Kalemli-Özcan, Silva, and Yıldırım (2022); di Giovanni, Kalemli-Özcan, Silva, and Yıldırım (2023)

programs of advanced countries, which itself was a response to the original negative aggregate demand shock due to pandemic (e.g. Gourinchas, Kalemli-Özcan, Penciakova, and Sander, 2021). The paper's focus is on import prices for the U.S. as a small open economy. This is not appropriate for the U.S. as any demand shock in the U.S. will affect both export and import prices and the amount of net exports, not only imports. This is important since import and export price endogeneity to the consumption reallocation shock (shift from domestic services to traded goods during 2021 and shift back to services in 2022) is a first order issue to get the timing and persistence of inflation right. As shown by di Giovanni, Kalemli-Özcan, Silva, and Yıldırım (2022), goods inflation started earlier than services inflation in 2021 and in 2022 when goods inflation was coming down, services inflation started picking up and drives inflation in 2023, as shown in di Giovanni, Kalemli-Özcan, Silva, and Yıldırım (2023).

The exogeneity of the labor supply shock, being a dis-utility shock, raises a similar issue. The decline in labor force participation in the data is due to a combination of demand and supply shocks. There are various reasons for the declining labor supply, such as the pandemic affecting desire to work in contact intensive sectors, lockdowns, higher reservation wage given government support, and numerous life-style changes. Modeling the labor supply shock as a preference parameter of not wanting to work creates difficulties in terms of calibrating this parameter as it is hard to make it consistent with the health shock, fiscal impulse and hand-to-mouth agents share all at once. Most importantly, as an exogenous preference shock, dis-utility of labor will not allow people to go back to work in the model, as happened in reality, and hence the model will assign the inflationary impact of the reduced unemployment and tight labor markets to somewhere else, underestimating the interaction between demand and labor supply shock on labor market tightness and the related sticky inflation.

My second set of comments is on the methodology of estimating impulse response functions to different shocks in the calibrated model. An alternative strategy would be to estimate the model and let the data speak to which shocks are important in driving inflation in a formal variance decomposition. An exercise of this latter sort is done in di Giovanni,

Kalemli-Özcan, Silva, and Yıldırım (2022); di Giovanni, Kalemli-Özcan, Silva, and Yıldırım (2023). These papers can account for the timing in inflation, goods sector first, services sectors later, and also can account for the simultaneous occurrence of slack and inflation in the aggregate economy in 2021, the focus year of the current paper. The above papers quantify that 2/3 of inflation is due to demand shocks and 1/3 from supply shocks in the U.S. The current paper does not do this but shows that their model is consistent with the behavior of inflation and also with consumption, output and wages. However, this requires to assume several exogenous shocks and assuming flexible adjustment of factors of production across two sectors, a counterfactual, since factor markets including labor remain segmented during this period, where jobs lost/gained in tradeable sector were not smoothed out by jobs gained/lost in non-tradeable sector, keeping labor markets tight in non-tradeable sector for over two years.

My final comments are on the quantitative importance of the parameters governing the elasticity of substitution. CPI inflation in this model comes from higher mark-ups and higher marginal costs. Each good (i) price is given by, $\log P_i = \log \mu_i + \log MC_i$. How important are mark-ups and cost pass-through quantitatively? The answer will depend on the elasticity of substitution parameter. And the effect of this parameter can be different on first and second-order terms, as typical in non-linear models. To see this, take equation (1):

$$\begin{aligned} \mathrm{d}\log MC_i &= \underbrace{\alpha_{iL}\mathrm{d}\log W + \alpha_{iM}\mathrm{d}\log P_M + \alpha_{iD}\mathrm{d}\log P_D}_{\text{First-Order Term}} \\ &+ \frac{1}{2}\boldsymbol{(1-\rho)}\underbrace{\left[\alpha_{iL}(1-\alpha_{iL})(\mathrm{d}\log W)^2 + \alpha_{iM}(1-\alpha_{iM})(\mathrm{d}\log P_M)^2 + \alpha_{iD}(1-\alpha_{iD})(\mathrm{d}\log P_D)^2\right]}_{\textbf{Isolated Effects}} \\ &+ \boldsymbol{(\rho-1)}\underbrace{\left[\alpha_{iM}\alpha_{iL}\mathrm{d}\log W\mathrm{d}\log P_M + \alpha_{iM}\alpha_{iD}\mathrm{d}\log P_D\mathrm{d}\log P_M + \alpha_{iL}\alpha_{iD}\mathrm{d}\log P_D\mathrm{d}\log W\right]}_{\textbf{Cross-Term Effects}} \end{aligned} \tag{1}$$

The paper's benchmark assumption is $\rho > 1$, that is inputs into production are substi-

tutable. This assumption drives all the results in the paper since when foreign inputs become expensive, there will be substitution towards domestic inputs, leading to a cost-push shock and inflation. If only the price of a single input changes, this affects marginal costs less as firms can substitute away towards other inputs. So in this case substitution dampens the single shock via "isolated effects" as seen in the equation above. However, if all input prices change with multiple shocks, their benchmark case, then substitution ($\rho > 1$) amplifies the effect on the marginal cost via "cross-term effects" as seen in the equation. This is the key insight coming from multiple shocks, showing up in the second-order term, affecting all inputs so the standard smoothing effect of substitution from one input to other input is muted. This is an important insight since the original view that supply chain disruption-led inflation should be transitory relies on this substitution from one input to another and relative prices adjusting, totally ignoring the global nature of the shock where all sorts of inputs used through vertical supply chains get shocked. If substitution is muted, relative price adjustment will not happen and foreign input shocks will have a larger inflationary effect.

What happens if $\rho < 1$? These effects are exactly reversed, now isolated effects get amplified and cross-effects are muted. However, ρ is estimated in the U.S. data to be less than 1 (e.g. Atalay, 2017; Carvalho, Nirei, Saito, and Tahbaz-Salehi, 2021; Raval, 2019; Oberfield and Raval, 2021), and internationally (e.g. Boehm, Flaaen, and Pandalai-Nayar, 2019; Boehm, Levchenko, and Pandalai-Nayar, 2023). This literature estimates the elasticity of substitution between value added and intermediate inputs as 0.6, and the elasticity between labor and capital as 0.5, and the elasticity between domestic and foreign inputs 0.2. The authors estimate 1/3 of the inflation coming from supply shocks assuming high elasticity of substitution between domestic and foreign inputs (under their robustness exercise of Leontief production function where domestic and foreign inputs remain to be substitutes based on evidence in Feenstra et al. (2018), which contradicts the recent AER paper (e.g. Boehm, Levchenko, and Pandalai-Nayar, 2023). This is because Feenstra et al. (2018) estimates

(a) $\rho = 0.6$ (b) $\rho = 1.5$

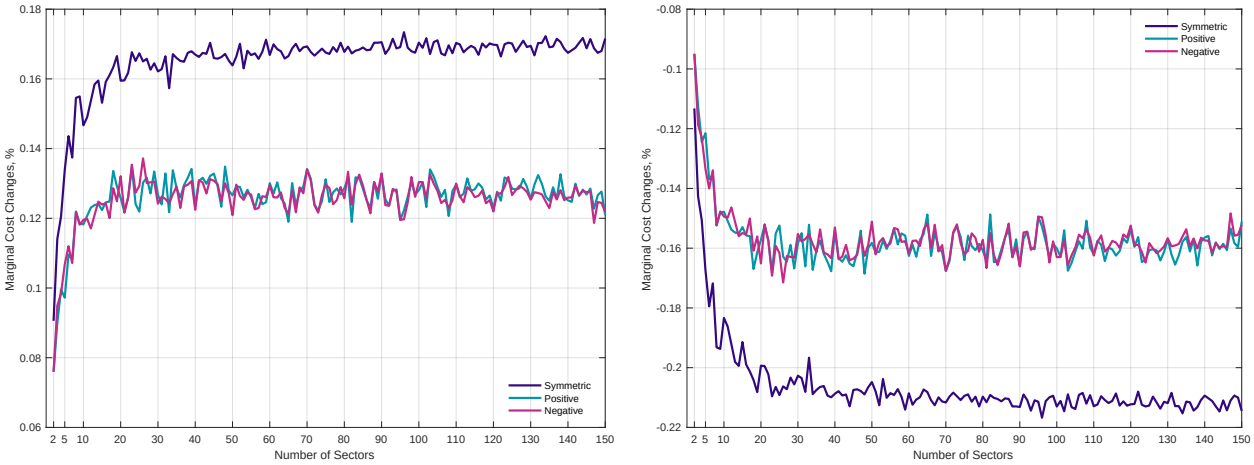

Figure 1: Channels strength as number of inputs increases. *Note:* Panel (a) shows the second-order terms with an elasticity of substitution among inputs equal to $\rho = 0.6$. Panel (b) repeats the exercise with an elasticity $\rho = 1.5$. Each point in the figure is the average across a 100 simulations. The purple line assumes expenditure share in all inputs is the same and equals $1/N$. The green (positive) line means shares are drawn from a pareto distribution with shape parameter 1.16 and are ordered such that inputs with larger expenditure shares receive larger shocks. The pink (negative) line uses the same distribution but ordered shares in increasing order, meaning that inputs with larger expenditure shares experienced lower price increases.

long-run elasticities where the recent work estimates short-run elasticities that should be the relevant elasticity for the current paper focusing only on a single year of 2021. Different models assuming exact reverse, a high degree of complementarity also find a similar effect; 1/3 of inflation coming from supply shocks. How is this possible? The exercise below explains this.

With complementarity between domestic and foreign inputs, amplification of marginal costs comes from isolated wage changes, whereas under substitution it comes form cross-effects. To reconcile these two seemingly contradictory outcomes, we need to take sectoral heterogeneity seriously: having 66 sectors of the U.S. economy instead of just 2 sectors matter. Same for factors of production: having 66 labor markets instead of just 2 matters and can describe the real life inflation better.

To show this, let me run a simple simulation. Elasticity in these experiments can be

either $\rho = 0.6$ or $\rho = 1.5$, to consider both cases of complementarity and substitution. I draw price changes from a uniform distribution with mean 0.16, to coincide with the import price changes they fed in. This means that all prices in my exercise go up but some go up more than others, to highlight the story they have in mind and to be as clear as possible. I conduct 100 simulations per each case. For example, I simulate the case when the number of inputs is $N = 2$ a 100 times and then I took the mean of the isolated effect, the cross-terms and their sum across these 100 cases. Then I do the same for $N = 3, 4, ...150$. All results I show below are average across these 100 simulations.

Whenever I add an input, it is not obvious how input shares should be set. To address this, I consider three possible distributions for the input shares and their correlation with the price changes:

- Symmetric: I assume all inputs have the same share equal to $1/N$. An additional input thus decreases the shares of all other inputs in the same proportion. Hence, here input shares are symmetric. This is shown in the purple line in each case in the plots below.

- Positive: I draw the input share distribution from a Pareto distribution with a tail parameter equal to 1.16 and position parameter equal to one. I ordered shares so that they are positively correlated with the price changes: input in which a firm spends more are the ones that experience the larger price increases. This is shown in the green line in each plot.

- Negative: I draw the input share distribution from a Pareto distribution with a parameter equal to 1.16. I ordered shares so that they are negatively correlated with the price changes: input in which a firm spends more are the ones that experience the lower price increases. This is shown in the pink line in each plot.

Regardless of how input shares drawn, sum of the isolated effects and cross-effects, that is the overall effect is positive only when $\rho = 0.6$ and not when $\rho = 1.5$. This suggests that second-order terms in this model cannot generate inflation but rather decrease the overall

impact of input price changes on inflation (relative to a log-linear world). Increasing the level of disaggregation (number of sectors on x-axis) increases the effect on inflation of the second order term when $\rho = 0.6$ and decreases it when $\rho = 1.5$. This is true with any configuration of the input shares. Hence, disaggregation coupled with a low elasticity of substitution rises inflation in a non-linear world relative to a log-linear world, while the opposite happens with values of the elasticity of substitution higher than 1. As a result, working with substitution between domestic and foreign inputs, as the authors do, decreases the quantitative importance of non-linearity in the calibrated model.

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