Appendix for Monetary Policy and Inequality

Alisdair McKay — FRB Minneapolis
Christian K. Wolf — MIT & NBER

January 6, 2023

A Details of indirect calculation of consumption effects

We report results from an indirect calculation of the consumption response to monetary policy. This calculation is premised on the following equation:

$$dc_i = \sum_j dp_j x_{ij} m_{ij} \tag{A.1}$$

where dc_i is the percentage change in consumption of household i after the change in monetary policy, dp_j is the change in the "price" of category j, x_{ij} is the exposure of household i to price j, and m_{ij} is the MPC of household i out of cash-flows of type j. We now describe how we construct each of these right-hand-side variables in turn.

Price changes. For each category j we construct an aggregate measure of how prices change. The data series are described in the table below. For housing returns we use the aggregate *value* of real estate held by US households, which in principle could reflect changes in quantities as well as prices. We are assuming that over a short period of time the change in value reflects price changes only.

We use the high-frequency monetary policy shocks identified by Gertler & Karadi (2015) to isolate quasi-random variation in monetary policy. For each variable, we run a simple recursive VAR with the shock ordered first (following the suggestion of Plagborg-Møller & Wolf, 2021), followed by real GDP, inflation, the 3-month Treasury bill rate, and the variable of interest. We use data from 1982Q3 to 2015Q3.[1] Using the estimated VAR we

[1] For business income, the results are very sensitive to including the Great Recession so for that variable we stop the sample at the end of 2007, but we note that this price change does not have a large impact on our overall calculation in any case.

Category	Data
Labor earnings	Wage and salary compensation, log real per capita
	$\log(COE) - \log(POP) - \log(GDPDEF)$
	Bureau of Economic Analysis (2022)
Business income	Proprietors income plus dividend income, log real per capita
	$\log(PROPINC + B703RC1Q027SBEA) - \log(POP) - \log(GDPDEF)$
	Bureau of Economic Analysis (2022)
Interest income	Interest income, log real per capita
	$\log(A064RC1Q027SBEA) - \log(POP) - \log(GDPDEF)$
	Bureau of Economic Analysis (2022)
Return on stocks	S&P 500 index return, real
	$\log(SP500) - \log(GDPDEF)$
	Bloomberg (2022)
Return on housing	Market value of real estate held by household sector, log real per capita
	$\log(HNOREMV) - \log(POP) - \log(GDPDEF)$
	Bureau of Economic Analysis (2022) and Federal Reserve Board (2022)
Return on cash	Inflation measured by log change in GDP deflator
	$-4 \times \Delta \log(GDPDEF)$
	Bureau of Economic Analysis (2022)
Mortgage rates	30-year fixed-rate mortgage, real
	$MORTGAGE30US/100$ less response of inflation as above
	Freddie Mac (2022)
Other interest rates	Rate on 4-year auto loan, real
	$TERMCBAUTO48NS/100$ less response of inflation as above
	Federal Reserve Board (2022)

Table A.1: Time series data description. All data apart from the S&P 500 were obtained from the Federal Reserve Bank of St Louis FRED database. The series identifiers are listed in the table.

then construct impulse responses to the monetary policy shock. The average level of the impulse response over the first two years following the shock is our measure of the price effect of monetary policy. For mortgage rates and other interest rates, we subtract the inflation response to approximate a real interest rate.[2] Furthermore, we divide the price response of these two interest rates by 2 to account for the incomplete pass-through to the interest rates households actually pay (see Figure 2).[3]

Household level exposures. We now describe how we construct the exposure of household i to price j. Our primary data source is the 2019 Survey of Consumer Finance (SCF). Take labor earnings for example. We set $x_{ij} = \gamma_{ij} y_{ij} / c_i$ where y_{ij} is wage and salary income of the household, c_i is an estimate of the baseline level of consumption, and γ_{ij} is the elasticity of the household's labor income with respect to changes in aggregate labor income. As the SCF does not include consumption data, we impute c_i using the household's income and the relationship between income and consumption expenditures in the 2019 wave of the Panel Study of Income Dynamics.[4] To understand this expression for x_{ij}, begin by supposing $\gamma_{ij} = 1 \forall i$. In this case, if aggregate wages increase by 1% (i.e. $dp_j = 0.01$), then $dp_j w_i$ represents a 1% increase in the wage income of household i. Dividing by c_i expresses this change in labor income as a proportion of their baseline consumption. Next, we incorporate the fact that low-income households are particularly exposed to business cycle fluctuations; i.e., γ_{ij} is decreasing in income. Specifically, earnings at the 10th percentile of the earnings distribution are about three times more sensitive to aggregate income than are earnings at the 80th percentile and the relationship is fairly linear in worker's rank in the earnings distribution below the 80th percentile (Guvenen et al., 2017). There is some evidence that earnings are more cyclical above the 80th percentile than at the 80th percentile, but this pattern did not hold in the Volcker disinflation (Guvenen et al., 2014), and therefore we assume a constant sensitivity above the 80th percentile. Overall we set $\gamma_{ij} = a - b \min(q_i, 0.8)$ where $q_i \in [0, 1]$ is the household's rank in the distribution of wage income. We choose b so that

[2] We measure the inflation response as the cumulative inflation response over the two years following the shock.

[3] The values reported in Table 1 are dp_j except for mortgages and other interest rates, where the values in the table are shown before the rescaling by 1/2.

[4] Specifically, we run a piecewise-linear regression of expenditure on income with a kink point at an income level of \$175,000. We used this piecewise-linear specification after examining the summary tables of the 2019 Consumer Expenditure Survey, which show expenditure rising nearly linearly in income up to the income level of \$150,000 to \$200,000. We experimented with adding richer household characteristics such as age, wealth and food consumption. These had little additional explanatory power in the PSID data.

earnings are three times more sensitive at the 10th percentile than at the 80th percentile. The parameter a is normalized so that aggregate earnings have a unit elasticity to aggregate earnings. For business income and interest income we set $x_{ij} = y_{ij}/c_i$—that is we assume an equal exposure to the aggregate ($\gamma_{ij} = 1$).

Turning to asset categories, first take housing as an example. We set $x_{ij} = h_i/c_i$ where now h_i is the value of housing held by household i. If house prices increase by 1%, then $dp_j = 0.01$ and $dp_j x_{ij}$ will tell us how the home value changes relative to the household's baseline consumption level. Stocks and cash are treated similarly. Finally, for mortgages and other liabilities we set $x_{ij} = b_i/c_i$ where b_i is the debt outstanding. If the interest rate paid on the debt increases by dp_j then the debt service payment increases by $dp_j x_{ij}$ as a share of baseline consumption. We include auto loans, credit card balances, and installment loans in the "other" debt category.

Marginal propensities to consume. We allow MPCs to vary across households and across cash-flow categories as described in Table 1. The variation across households is driven only by a classification of households into two groups: financially constrained and unconstrained. This classification is based on a threshold level of liquid assets. Households with liquid assets less than two weeks' income are categorized as constrained. Here liquid assets include transaction accounts and other liquid financial assets, but exclude non-financial assets and retirement assets. Following Slacalek et al. (2020), we use MPCs of 0.05 and 0.5 for unconstrained and constrained households' response to changes in income and the value of transaction accounts. For housing and stocks we use MPCs of 0.03, consistent with estimates from Guren et al. (2021) and Chodorow-Reich et al. (2021). If constrained households own these assets, then they are illiquid, and thus we use those low MPCs for all households. Lastly, we apply large MPCs to debt service payments. Theoretically, a change in a mortgage payment is a very persistent change in disposable income so we would expect a high MPC regardless of whether or not a household is constrained. Di Maggio et al. (2017) analyze the way households respond when their mortgage interest rates change. They find a large response of consumption as measured by auto purchases, but they also find that households on average use 8% of the increase in disposable income to pay down mortgage debt. Furthermore they find that high-income households are more likely to pay down debt. Motivated by this evidence, we set an MPCs of 0.8 for unconstrained households and 1.0 for constrained households.

Putting it all together and a consistency check. We construct consumption changes for each household according to equation (A.1). To construct Figure 3, we omit households with net worth in excess of \$2.5 million, and then create quintiles of households by net worth, income, and age, and report the average dc_i within each quintile.[5]

The response of aggregate consumption implied by the figure is 0.9%, which encouragingly is similar to the 0.7% value that we obtain by including aggregate consumption in the monetary policy VAR that we used to construct the price changes.

[5] We chose to drop high-net worth households from this analysis because we are not confident that our consumption imputation and MPC assumptions apply well to these households.

References

Bloomberg. S&p 500 index quarterly closing values. (accessed Aug. 5, 2022).

Bureau of Economic Analysis (2022). National income and product accounts. (accessed Aug. 5, 2022).

Chodorow-Reich, G., Nenov, P. T., & Simsek, A. (2021). Stock market wealth and the real economy: A local labor market approach. *American Economic Review*, *111*(5), 1613–57.

Di Maggio, M., Kermani, A., Keys, B. J., Piskorski, T., Ramcharan, R., Seru, A., & Yao, V. (2017). Interest rate pass-through: Mortgage rates, household consumption, and voluntary deleveraging. *American Economic Review*, *107*(11), 3550–88.

Federal Reserve Board (2022). Finance rate on consumer installment loans at commercial banks. Consumer Credit - G.19 Release. (Accessed Aug 5, 2022).

Freddie Mac (2022). 30-year fixed rate mortgage average in the united states. (accessed Aug. 5, 2022).

Gertler, M. & Karadi, P. (2015). Monetary policy surprises, credit costs, and economic activity. *American Economic Journal: Macroeconomics*, *7*(1), 44–76.

Guren, A. M., McKay, A., Nakamura, E., & Steinsson, J. (2021). Housing wealth effects: The long view. *The Review of Economic Studies*, *88*(2), 669–707.

Guvenen, F., Ozkan, S., & Song, J. (2014). The nature of countercyclical income risk. *Journal of Political Economy*, *122*(3), 621–660.

Guvenen, F., Schulhofer-Wohl, S., Song, J., & Yogo, M. (2017). Worker betas: Five facts about systematic earnings risk. *American Economic Review*, *107*(5), 398–403.

Plagborg-Møller, M. & Wolf, C. K. (2021). Local projections and VARs estimate the same impulse responses. *Econometrica*, *89*(2), 955–980.

Slacalek, J., Tristani, O., & Violante, G. L. (2020). Household balance sheet channels of monetary policy: A back of the envelope calculation for the euro area. *Journal of Economic Dynamics and Control*, *115*, 103879.