Transmission Mechanisms in HANK: an Application to Chile

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Online Appendix

A Assets decomposition, different Data Sources

Liquid				Illiquid				Total
		EFH	CMF			EFH	CMF+CBC	
	Banking Credit Cards	-0.011	-0.0322	Net housing	Net Primary House	0.898	1.93 (-0.251)	
	Banking Credit Lines	-0.003			Net Other House	0.384		
	Banking Consumption Credits	-0.027	-0.0795					
Revolving consumer debt	Non-Banking Credit Cards	-0.005						
	Non-Banking Consumption Credits	-0.003						
	Cooperative Credits	-0.005						
	Other Loans	-0.003	-0.008					
		-0.06	-0.12			1.282	1.93	
Deposits		0.01	0.05					
	Bonds	-	0.012					
Fixed income	Saving Accounts	-	0.105					
	Saving Insurance	-		Net durables	Net Cars	0.106		
	Other	-			Other Real Assets	0.022		
		0.056	0.12			0.128	0.128	
	Shares	-	0.003					
Equity	Mutual Funds	-	0.07					
	Other	-						
	Investment Funds	-	0.044	AFP		0.187	0.722	
		0.083	0.114					
APV		-						
Education Loans		-0.014						
Total		0.08	0.164			1.597	2.06	2.23

TABLE 1: Values are expressed as a fraction of 2017 GDP.

B The Household Finance Survey (EFH)

The Household Finance Survey (*Encuesta Financiera de Hogares*) - EFH - is a national waves survey carried out every 3 years by the Central Bank of Chile. The latest waves are from years 2011, 2014, 2017 and 2021 (due to COVID reasons it had to be delayed one year). The EFH aims to characterize the financial balance of chilean households. Specifically, the survey inquires on the position of the

household's savings, debts, income, financial assets, use of means of payment, accessibility to the financial system, among others[1].

The survey identifies the Head of each household, collapsing all information the rest of the members on her/his answers. We identified that household, where the Head of it is less than 22 years old are mostly students, the majority of them with financial assistance from a family member, thus they do not fit into the scope of our analysis (they belong to a household that we do not possess information about). The other group we left out are the ones where the Head of the household is older than 79 years. The reason of exclusion follows the same spirit of the younger ones. The majority of these households receive some form of aid from their sons and/or daughters, making the analysis bias (we do not have information about the earning, debt and assets of the other households).

The survey contemplate questions regarding the labor, pension income, government transfers, subsidies, all treated as income. There are households whose main labor income is reported as self-employment. When analysing the current month income in annual terms and the last year income there are significant differences. As we can not identified the real income of these households we decided to remove them from the analysis[2].

On the side of the household's wealth, the survey identifies well the debt and assets positions. On the one hand, this survey ask about the accessibility to credit cards and the amount percentage of the disposable credit used (currently and in the last year). Additionally, there are questions about each household's member loans position. On the other side, there are several questions about the amount of disposable money in the bank accounts (the survey asks about the current amounts as well as the mean of the last year) and the amount not targeted to be used to pay bill in the current month. Additionally, there are several questions regarding the financial assets holdings.

C Obtaining the Shares of Hand-to-Mouth and robustness analysis

In the current appendix we discuss the construction of the share of Hand-to-Mouth using the *Encuesta Financiera de Hogares 2017 (EFH 2017)*. There is a newer version of this survey (EFH 2021), however, we stick to 2017 wave due to the allowance of the pension funds withdrawals taken during 2020 and 2021 to face the impact of the COVID-19 pandemic. As consequence of the aforementioned

[1] This survey follows the oversampling of wealthier urban households and is representative of the sub-populations at the macro-zone level.

[2] Also as doing this we are been consistent with the labor income definition used in section 2.3.

TABLE 2: Shares of HtM

		Share of HtM					Share of HtM		
Asset def.	Illiquid Assets def.	Poor	Rich	Total	Asset def.	Illiquid Assets def.	Poor	Rich	Total
	Principal Home	0.14	0.29			Principal Home	0.12	0.27	
SR wo. E	All Real Estates	0.12	0.31	0.43	12m Saving wo. E	All Real Estates	0.11	0.28	0.39
	Real Estates & Durables	0.08	0.35			Real Estates & Durables	0.08	0.31	
	Principal Home	0.14	0.30			Principal Home	0.12	0.28	
SR w. E	All Real Estates	0.12	0.32	0.44	12m Saving w. E	All Real Estates	0.11	0.29	0.40
	Real Estates & Durables	0.08	0.36			Real Estates & Durables	0.07	0.33	

measures at that point in time Households kept an unusual amount of liquid Assets compared to any other time analyzed.

The EFH 2021 contains question regarding the Household's Asset stock, income, present valued debt, access to the financial market, among others. All Assets and debt is aggregated in the head of the Household answers. Table 10 is constructed using three common assumptions to construct the share of HtM.

First of all, we kept only the self-identified Head of the Household. The second common assumption is to eliminate all Households, where the Head of it is younger than 22 years old and the ones older than 79 years old. Finally, we drop all IDs where it is reported to have received a negative income.

There is a last assumption on the Entrepreneurs population on the survey (it makes to vary the remaining total Households in tha sample). There are Households who report to been entrepreneurs as their primary source of income. The first option we made is to drop them out of the sample, as their reported income may be not representative of the gross annual income due to the volatile nature of some entrepreneurs. The definition under this assumption is presented in the top panel of table 2 (expressed as wo. E). The bottom panel of the table shows the shares of HtM Households made under a softer measure of the dropped Entrepreneurs, we only drop a Household, that do not report the income (presented as w. E).

Focusing on the Asset holding, we added up all self-reported net values of the Asset, such as, Deposits, Fixed Income Assets[3], the Equity Assets[4], net of the reported debt[5]. This way to sum up the net liquid Asset holding is presented in the left hand panel in table 2 under the label of self-reported (SR). There is an additional check it can be made. The EFH 2017 contains an additional

[3]Correspond to the total amount households have invested in different instruments such as time deposits, bonds, savings accounts, and insurance with savings.

[4]The sum of investments in shares, investments in mutual funds, participation in companies or investment funds, and investments in other equity instruments (options, futures, swaps, among others).

[5]Bank credit cards, lines of credit, bank or financial consumer loans, credit cards from non-banking institutions, consumer loans in commercial houses (cash advances), credits in savings banks compensation, cooperatives or other similar, educational loans, and other non-mortgage debts.

question regarding the saves made by the Household during the 12 months to the survey. Thus, it is possible to correct one last time the possible misreporting of the liquid Asset holding described above. The aforementioned replacement is presented in the right-hand side of table 2 under the *12 m Saving* label.

Finally, there are three different ways in which the illiquid Assets can be grouped. The first definition used in the analysis was to considered only the net valuation of th principal Home as the illiquid Asset holding - presented in the top panel of each subcategory -, then we used the possession of all real estates net valuation (the middle panel of each subcategory). Finally, we considered all real estates plus the reported durables Assets net of their debt as the illiquid Asset holding (the bottom panel in each subcategory explained before).

The preferred subcategory to Measure the HtM Households of the chilean economy is the 12m Saving wo. Entrepreneurs, take as the illiquid Assets all Real Estates plus Durables. It allows to correct the possibility of misreporting and takes into account all material Assets outside of the finacial markets.

C.1 Robustness Analysis

TABLE 3: Dichotomic Share of HtM

	No Sav. last 12m	No CC possession	No Checking Acc.	No Cred Line Acc.	No CLA, CC nor NBCC
wo. E	0.3646	0.3677	0.0835	0.3502	0.1791
w. E	0.3744	0.3792	0.0854	0.3614	0.1846

As discussed above the measure of HtM Households may vary depending in the assumptions one follows when constructing the ratio. We created some dichotomic based shares of HtM to have a bottom (soft) estimate of the ratio. The EFH 2017 contains questions about the availability of some financial instruments and if the people in it were able to save any amount during the last 12 months. We looked at the ratio of the Households under both Entrepreneurs assumption, whether it possess some financial instruments, such as Banking Credit Card, Checking Account, Credit Line Account and any of the aforementioned instruments. Additionally, we obtained the ratio of Households that reported to have save any amount during the last 12 months prior to the survey. The results are presented in table 3.

Table 3 shows some interesting facts. First of all the ratio of Checking Account availability in the chilean economy is much wider than any other ratio considered in the analysis is due to Government

policy of managing via Banco Estado - a Commercial Bank with Government ownership - to have available to any 18 years old citizen a Checking Account with a limit to have in it. Thus, there should be no friction in the accessibility to this specific financial instrument.

Table 4 presents the average of the ratio between the instrument limit given by the financial system and the quarterly income of the entire Household. The three analyzed instruments show that the amount given to the Households does not cover them for a large period of time. The available level of credit covers less than two months of income in case of losing a job on average terms. This ratio is considering the ideal case, where the limit is at full disposal. A better way to get the constrained Household that have a financial instrument to their disposal is presented in table 5.

TABLE 4: Financial instrument limit as quarterly income (ratio)

	Credit Cards	Credit Lines	No banking CC
wo. E	0.6819	0.4604	0.5808
w. E	0.6795	0.4857	0.5678

Table 5 shows two different measure of a soft HtM ratio. The first measure are those Households that have all their available credit used (in the respective financial instrument). If we take the Total column this share of HtM Households is around 0.25, to obtain the amount of HtM in the aggregate level it is necessary to add the 0.18 of those Households that do not have any financial instrument (presented in the last column of table 3), what give us that this soft HtM measure is around 0.43. Once again near the shares obtained in the principal analysis.

TABLE 5: Spare amount in Credit Cards as HtM Measures

	Banking CC	Non-Banking CC	Total
No amount available to be used	0.258	0.282	0.25
Less than 15% of quarterly income to spare	0.441	0.598	0.476

D Tables and Figures

D.1 Empirical

Finally, Table 6 in the Appendix compares the income risk moments between Chile and the U.S. at an annual frequency. In Chile, income inequality is 50% larger than in the U.S., measured as the variance of the log of earnings. Income volatility is higher as well as measured by the variance and

the kurtosis of the changes of the log labor earnings. The variance of one and five-year growth in Chile are twice as large as the ones in the U.S., a similar phenomenon happens with the kurtosis which is larger for the U.S. than for Chile, meaning that the probability of receiving a shock in the U.S. is significantly lower than in Chile. These facts are consistent with previous evidence that the labor market in Chile is significantly more dynamic than in OECD countries, Albagli et al. (2017).

Moments	United States	Chile (Full sample)	Chile (Sub-sample)
Variance: log earns	0.70	1.14	1.12
Variance: 1-year change	0.23	0.53	0.48
Variance: 5-year change	0.46	0.88	0.82
Skewness: 1-year change		0.00	-0.14
Skewness: 5-year change		-0.02	-0.14
Kurtosis: 1-year change	17.8	6.80	7.47
Kurtosis: 5-year change	11.6	5.15	5.68

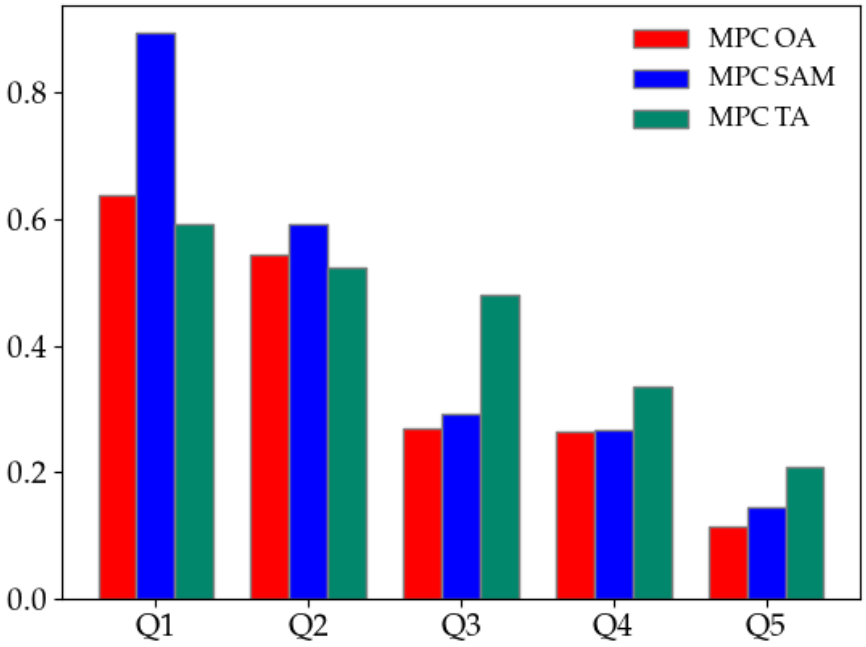
TABLE 6: Empirical moments for earnings in United States and Chile at annual frequency.

Moments	Full sample	2014-2019
Variance: log earns	0.70	0.69
Variance: 1-qtr chg.	0.21	0.18
Variance: 1-year chg.	0.30	0.26
Variance: 5-year chg.	0.49	0.43
Skewness: 1-qtr chg.	0	-0.07
Skewness: 1-year chg.	0	-0.11
Skewness: 5-year chg.	0	-0.06
Kurtosis: 1-qtr chg.	10.15	11..69
Kurtosis: 1-year chg.	8.47	9.63
Kurtosis: 5-year chg.	5.69	6.45

TABLE 7: Empirical moments for earnings in Chile at quarterly frequency. All workers.

D.2 Figures of Section 5

FIGURE 1: MPCs Comparison



E Details of the model

E.1 Firms

Intermediate firms solve:

$$J_t(p_{jt-1}) = \max_{y_{jt},p_{jt},k_{jt},n_{jt}} \left\{ \frac{p_{jt}}{p_t} y_{jt} - h_t n_{jt} - r_t^k k_{jt-1} - \frac{\mu_p}{\mu_p - 1} \frac{1}{2\kappa_p} \left[\log(1+\pi_{jt})\right]^2 y_{jt} + \frac{J(p_{jt})}{1+r_{t+1}^a} \right\}$$

$$\text{s.t.} \quad y_{jt} = Z_t k_{jt-1}^{\alpha} n_{jt}^{1-\alpha},$$

$$y_{jt} = \left(\frac{p_{jt}}{p_t} \right)^{-\frac{\mu_p}{\mu_p - 1}} Y_t.$$

The first-order conditions, after symmetry, read

$$\log(1+\pi_t) = \kappa_p \left(mc_t - \frac{1}{\mu_p} \right) + \frac{1}{1+r^a_{t+1}} \frac{Y_{t+1}}{Y_t} \log(1+\pi_{t+1})$$
$$h_t = (1-\alpha) mc_t \frac{Y_t}{N_t}$$
$$r^k_t = \alpha\, mc_t \frac{Y_t}{K_{t-1}}$$

where mc_t is the marginal cost.

E.2 Mutual Fund

The mutual fund solves the following problem:

$$A_0 := \max_{\{K_{s+1}, I_s, X_{s+1}\}} \sum_{s=0}^{\infty} \left(\frac{1}{1+r^a_s} \right) \left[r^k_t K_t - I_t - \Gamma(K_{s+1}, K_s) + \varpi \Pi_s X_s - q^x_s ((1+r^a_s) X_{s+1} - X_s) \right]$$
$$\text{s.t.} \quad K_{s+1} = (1-\delta) K_s + I_s$$

where $\Gamma(K_{t+1}, K_t) = \frac{1}{2\delta\epsilon_I} \left(\frac{K_{t+1}-K_t}{K_t} \right)^2 K_t$

The first-order conditions with respect to capital, investment, and stocks are:

$$(1+r^a_{t+1}) q^k_t = r^k_t - \left[\frac{K_{t+1}}{K_t} - (1-\delta) + \frac{1}{2\delta\epsilon_I} \left(\frac{K_{t+1}-K_t}{K_t} \right)^2 \right] + \frac{K_{t+1}}{K_t} q^k_{t+1}$$
$$q^k_t = 1 + \frac{1}{\delta\epsilon_I} \left(\frac{K_{t+1}-K_t}{K_t} \right)$$
$$q^x_t = \frac{(1-\varpi)\Pi_{t+1} + q^x_{t+1}}{1+r^a_{t+1}}$$

E.3 Sticky Wages

We assume households cannot decide their labor supply directly. Instead, there is a union that supplies aggregate labor. In each household i there is a continuum of tasks denoted by $g \in (0,1)$. A task-specific union decides nominal wages W^g_t for an amount of hours N^g_t. In this setting, unions have market power as workers' tasks are in monopolistic competition. The union aggregates individual labor such that $N^g_t = \int n^g_t(\boldsymbol{s}) d\boldsymbol{s}$. Then, we assume there is a Dixit-Stiglitz aggregator that determines aggregate labor, given by:

$$N_t = \left(\int_0^1 (n^g_t)^{\frac{\varepsilon_w - 1}{\varepsilon_w}} dg \right)^{\frac{\varepsilon_w}{\varepsilon_w - 1}},$$

where ε_w is the elasticity of the demand for labor tasks, which is also a measure of the market power of the union. The Dixit-Stiglitz aggregator gives rise to the following demand for each task g:

$$n_t^g = \left(\frac{W_t^g}{W_t}\right)^{-\varepsilon_w} N_t.$$

We assume nominal wages are sticky and their changes are subject to Rotemberg adjustment costs in logs. The problem of the union is to the nominal wage and the wage inflation rate by solving:

$$\begin{aligned} U(w_{gt-1}) = \max_{n_{gt}, w_{gt}} & \int (u(c_{it}) - v(n_{it})) \ \ d\Psi_t(\boldsymbol{s}) - \frac{\mu_w}{\mu_w - 1} \frac{1}{2\kappa_w} \left[\log(1+\pi_{gt}^w)\right]^2 N_t + \beta U_{t+1}(w_{gt}) \\ & s.t. \\ n_{gt} &= \left(\frac{w_{gt}}{w_t}\right)^{-\frac{\mu_w}{\mu_w - 1}} N_t \\ \pi_{gt}^w &= (1+\pi_t)\frac{w_{gt}}{w_{gt-1}} - 1. \end{aligned}$$

This setup leads to a wage Phillips curve in the main text, (5).

E.4 Government

The government, in our setting, allocates its spending between government consumption G_t, fiscal transfers to households $f_t(z)$, and unemployment benefits. Transfers are heterogeneous across households and can be progressive $f_t'(z) < 0$), $f_t'(z) > 0$, or flat $f_t'(z) = 0$. The way transfers are distributed across households satisfies $\int f_t(z)\Psi(\boldsymbol{s})d\boldsymbol{s} = T_t$, where T_t denotes the aggregate amount of transfers. The government finances its spending by issuing real-denominated debt B_t^g and by levying taxes on labor income, τ_t. Government debt is held by households in their liquid account and pays the return r_t^b. Transfers are lump-sum in the sense that households take these as given and do not enter the first-order conditions. However, they affect optimal decisions due to market incompleteness.

The government's budget constraint is then given by

$$B_{t+1}^g = T_t + G_t - \tau_t w_t N_t + (1+r_t)B_t^g.$$

The evolution of the fiscal balance depends on a smoothing parameter ρ_x, which determines to what extent additional spending is financed with debt according to:

$$\Delta B_t^g = \rho_x(\Delta B_{t-1}^g + \Delta X_t) \tag{1}$$

where X_t can be T_t or G_t, where the steady-state level of debt is determined in the market for bonds where households participate with their savings. The fiscal balance rule in equation 1 captures the fact that governments do not necessarily raise taxes to finance additional spending, as they can also issue more debt. Naturally, the government financing strategy is key for characterizing consumption dynamics as the Ricardian equivalence does not hold in these models.

F Response to a Monetary shock in SW-OA v/s SAM-OA

It is also useful for us to compare the different settings analyzing monetary policy shocks. Figure 2 shows the response of aggregate variables to a monetary policy shock in the calibration we used before. However, we calibrate the size of the monetary policy shock to generate the same response of consumption on impact we observe in both models. We do that to study the transmission mechanism of the shock more closely. The first we find is that due to the nature of the frictions we have in both models, inflation is more responsive in SW-OA than in SAM-OA. This is because of the stronger price rigidity wage rigidities generate. Also, we have that investment responds more strongly in the SAM-OA than in the SW-OA. That is due most likely to the stronger response of marginal costs that is positively related in this model to the return to capital.

Figure 3 shows the decomposition of consumption to the monetary policy shock in two terms, the direct response to the interest rate given by the dark-green bar, the average-indirect in dark-red and the cross-sectional indirect in light-red. We can mention several results from this plot. First, that the direct effects are very similar, accounting for a small portion of the total effect on impact. Second, from all of the indirect effects, the cross-sectional term is what drives the expansion in consumption. We observe that the average responses of income (labor income and income from dividends) go down, whereas the cross-sectional effect counteracts that. This is, monetary policy operates in this case in both models through the cross-sectional effect. The third result relates to the difference between SW-OA and SAM-OA, where the former has a more persistent response, which is mainly due to the persistence of employment this model has.

Overall, we find that, unlike the case of a fiscal transfer, a monetary policy shock has a similar transmission mechanism in both models. This means that properly calibrated, we can use both of

them for the analysis of the transmission of monetary policy shocks.

FIGURE 2: IRF Monetary Policy Shock

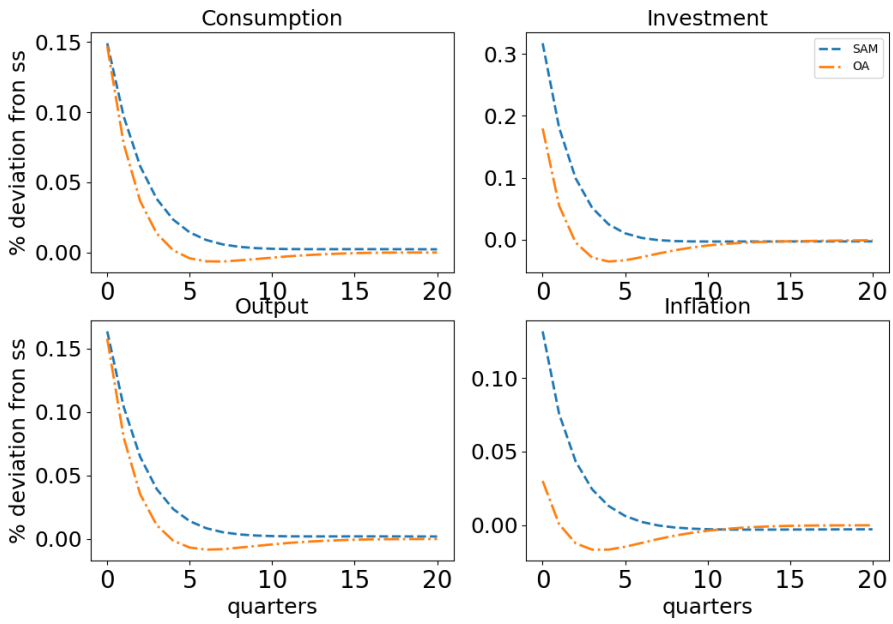
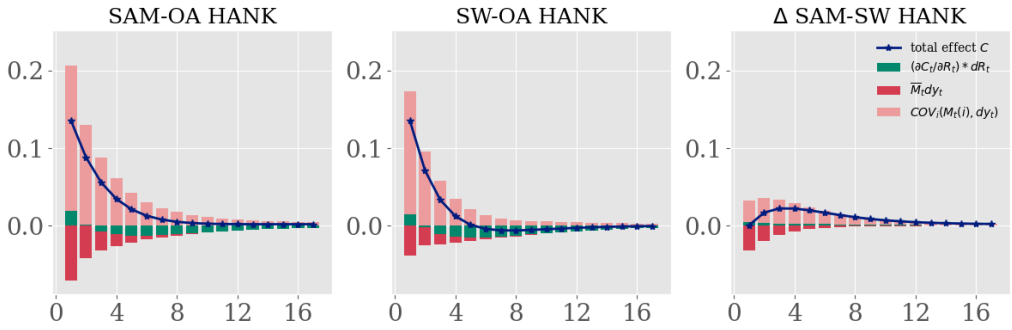


FIGURE 3: IRF Monetary Policy Shock Decomposition



G The Role of Investment in the Monetary Transmission in SW-OA and SW-TA

Figure 4 shows the comparison between SW-OA and SW-TA varying the parameter of capital adjustment costs function from high cost ($\epsilon^I = 0.5$) to low cost ($\epsilon^I = 6$). Notice that in this case, we observe a very different investment response, while again it is stronger in the SW-TA than in the SW-OA due to the endogenous illiquid investment. Additionally, the response of consumption

changes significantly, which is due to the higher income generated by a higher–and more persistent– capital. Capital takes a few quarters to increase and generate higher wages and dividends, which is the reason for the more persistent consumption response.

FIGURE 4: IRF Monetary Policy Shock SW-TA v SW-OA, $\epsilon^I = 6$

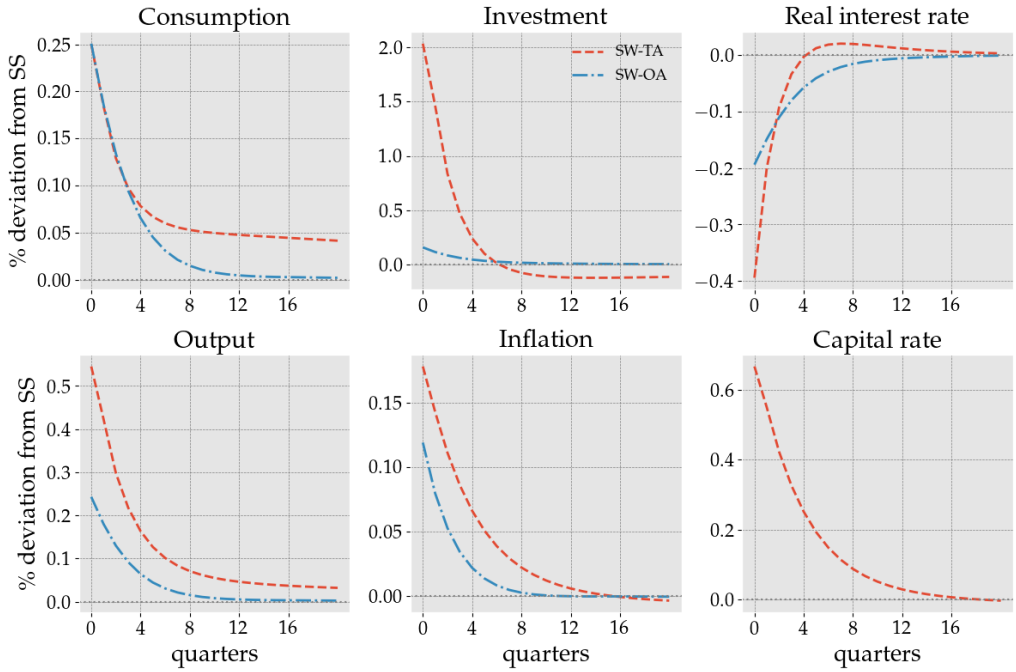
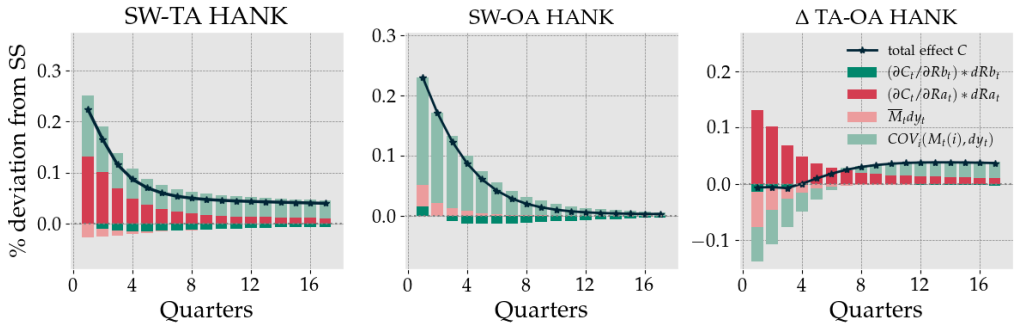


Figure 5 shows the decomposition for the case of low capital adjustment costs. The figure shows that the consumption response is now due more to the response of income, particularly the cross-sectional effect. We also observe that the effect of the illiquid interest rate is still strong but milder than with higher capital adjustment costs.[6]

FIGURE 5: IRF Monetary Policy Shock Decomposition, $\epsilon^I = 6$



[6]The effects of investment in HANK is also studied by Alves et al. (2020) that extend Kaplan et al. (2018) with capital adjustment costs and by Auclert et al. (2020) show that investment is key to the transmission mechanism of monetary policy in HANK.

References

Alves, F., G. Kaplan, B. Moll, and G. L. Violante (2020). A further look at the propagation of monetary policy shocks in hank. *Journal of Money, Credit and Banking 52*(S2), 521–559.

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