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A note on the fed's power to lower inflation

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Abstract
This note argues that the Fed does not have much effect on inflation expectations and that its effect on aggregate demand, and thus on inflation, is modest. Econometric results suggest that a short term interest rate increase of 1.0 percentage point results in a decrease in inflation of 0.43 percentage points after five quarters. The unemployment rate is 0.17 percentage points higher. Therefore, lowering inflation by 2 percentage points, if this is needed, requires about a 4 to 5 percentage point increase in the interest rate, with the full effect taking about five quarters.

1 Introduction

A common view held a few months ago by policy makers, including the Fed and officials in the Biden administration, was that the recent increase in inflation is transitory. It was argued that inflation would mostly subside by itself because much of the increase is due to supply bottlenecks and shifts away from services to goods, which will go away as the pandemic subsides. This view has changed as inflation has persisted, where at its March 16, 2022, meeting the Fed raised the federal funds rate by 25 basis points to 0.50 percentage points and announced that further increases were in store. The median projection of the federal funds rate for the end of 2022 from the dot plots was 1.9 percentage points, with a range of 1.4 to 3.1. In addition the Fed announced that it expected to begin reducing its holdings of Treasury securities and agency debt and agency mortgage-backed securities at a coming meeting. Chair Powell at his press conference estimated that this might be equivalent to about a 25 basis point increase in the funds rate. The median projection of the funds rate for the end of 2023 was 2.8, as was the median projection for the end of 2024. The inflation rate (PCE inflation) was projected to fall to 2.7 percent by the end of 2023 and 2.3 percent by the end of 2024, with a long-run projection of 2.0 percent. Given that the Fed has begun to tighten, the question is how tight will it have to be? Is the Fed correct that an increase in the federal funds rate to 2.8 percent by the end of 2023 will be enough to lower inflation back down to a little over 2 percent by the end of 2024? Behind this view, which many share, is agreement on the following:

(1) Inflation is strongly influenced by inflation expectations.
(2) Inflation expectations are largely determined by the Fed through its monetary policy (federal funds rate and quantitative easing or tightening) and its announced future plans.
(3) Modest increases in the federal funds rate are sufficient to lower inflation, in large part because of the Fed's strong influence on inflation expectations.

This note argues that (2) and (3) are inconsistent with empirical evidence. The literature on the determination of inflation expectations, discussed in Sect. 2, suggests that monetary authorities are not big players in determining such expectations. Future inflation expectations depend in large part simply on actual current and lagged inflation. If the Fed does not directly affect expectations much, then the main channel through which it influences inflation is by tightening monetary policy and contracting the economy. It is the action of the Fed via its effect on the real economy that influences expectations, not its speeches and announcements. If inflation responds sluggishly to aggregate demand, which many price equations suggest, then it may take large decreases in aggregate demand to lower

The baseline forecast from the US model that is used in this note is presented on the website fairmodel.econ.yale.edu. The results in Tables 3 and 4 in this note can be duplicated on the site. Alternative experiments can also be run.

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Table 1 Notatiion

Variable	Definition
GDPR	Real GDP
JF	Number of private sector jobs
PCPF	Percentage change in *PF*, annual rate, called "inflation"
PF	Private non farm price deflator
RS	Three-month Treasury bill rate, assumed Fed controls this
UR	Unemployment rate

inflation substantially. In addition, there is econometric evidence, discussed in this note, that aggregate demand is only modestly affected by interest rate changes, so fairly large increases in interest rates are needed to decrease aggregate demand enough to substantially lower inflation. There are also lags, and it can take a number of quarters for the full effects to be realized.

Consistent with the results in this note, a number of economists have argued that the Fed has been too optimistic about its ability to lower inflation. See, for example, a summary of the views of a number of economists at the January 2022 ASSA meetings in Miller and Rich (2022). There is, however, little econometric evidence backing these views; they are mostly just opinions based on casual observations of past episodes. The results cited here are econometric results, based on quarterly data back to 1954. The model is completely estimated (by 2SLS); there is no calibration.

Variable notation is presented in Table 1. The short term interest rate used in this note is the three-month Treasury bill rate, denoted *RS*. This is the rate the Fed is assumed to control rather than the federal funds rate. Short term interest rates are highly correlated, and it makes little difference which rate is used.

To preview the results: A sustained 1.0 percentage point increase in *RS* results in a decrease in inflation of 0.43 percentage points after five quarters. The unemployment rate is 0.17 percentage points higher. Therefore, lowering inflation by 2 percentage points, if this is needed, requires about a 4 to 5 percentage point increase in the interest rate, with the full effect taking about five quarters.

The message of this note is pessimistic. To the extent that inflation by itself will not go back to 2 percent and thus that the Fed needs to act, the Fed's powers are less than is generally realized. There is no evidence that it has much control over expectations, and its ability to influence aggregate demand, and thus inflation, is modest and takes time.

2 What Determines Inflation Expectations?

The inflation expectations that matter for Eq. (1) in Sect. 3 are the expectations of firms, since firms are the agents setting prices. My reading of the literature on firms' inflation expectations is that they are largely determined by firms' perceptions of current and past inflation. An early paper supporting the view that expectations of future inflation depend mostly on past inflation is (Fuhrer 1997). Fast forward to the present,(Candia et al 2020) have an informative review of the recent literature on how inflation expectations are formed. The evidence shows that household and firm expectations tend to differ considerably from market expectations and those of professional forecasters. The evidence also shows that the strongest predictor of households' and firms' inflation forecasts are what households and firms believe inflation has been in the recent past. There is also little evidence that firms know much about monetary policy targets. Further evidence from a survey of firms that began in 2018 is presented in Candia et al (2021). This survey finds no evidence that firms' expectations of future inflation are anchored. The findings suggest that there is systematic inattention to monetary policy: "...we find that most CEOs are unaware of the Federal Reserve's inflation target. The fraction of CEOs that correctly identifies 2 percent as the inflation target is less than 20 percent. Nearly two thirds of CEOs are unwilling to even guess what the target is. Of those who dare, less than 50 percent think it is between 1.5 and 2.5 percent." (Candia et al 2021, p. 4).

Another recent survey, of firms in France, described in Savignac et al. (2021), shows that firms' inflation expectations depend in large part on their perceptions of past inflation. The results also suggest that firms are not that knowledgeable about macroeconomics in that they perceive little link between price and wage inflation.

D'Acunto et al (2022) review the literature on households' inflation expectations. The story is the same for households as it is for firms. Households' inflation expectations appear to be primarily determined by observations of current and past inflation, particularly of grocery store prices and gasoline prices. There is no evidence that monetary authorities' announcements play any role in determining these expectations.

If firms' expectations of future inflation depend mostly on current and past inflation, then the way the Fed can influence future inflation is by changing current inflation. Announcements about targets, future policy moves, and the like, have little if any effect on expectations. The story seems to be that as actual inflation increases (say from some shock) firms begin to perceive this, perhaps with a lag, which then affects their inflation expectations and pricing decisions.

3 Price Equations

Given the evidence that the Fed does not control expectations directly, two effects must be estimated to examine the size of the Fed's effect on inflation. The first is the effect on aggregate demand from changes in short-term interest rates. The second is the effect on inflation from changes in aggregate demand. The second effect is discussed in this section; it concerns the estimation of price equations. In the following discussion the unemployment rate (UR) is taken as the measure of aggregate demand. A measure of the output gap could also be used.

A common price equation in the literature is the expectations augmented Phillips curve:

$$\pi_t = \pi^e_{t+1} + \beta(u_t - u^*) + \gamma s_t + \epsilon_t \ , \quad \beta < 0, \quad \gamma > 0, \tag{1}$$

where t is the time period, π_t is the rate of inflation, π^e_{t+1} is the expected rate of inflation for period $t+1$, u_t is the unemployment rate, s_t is a cost shock variable, ϵ_t is an error term, and u^* is the NAIRU.[1]

A key question is how π^e_{t+1} is determined. One possibility is that the Fed can directly affect π^e_{t+1} through policy announcements and the like. If so, then, as discussed above, one can be optimistic about the Fed's ability to control inflation. However, the evidence discussed above suggests that the Fed cannot do this, and that π^e_{t+1} is largely a function of lagged values of inflation.

If it is assumed that agents look only at past inflation in forming their expectations of future inflation, a common specification is:

$$\pi^e_{t+1} = \sum_{i=1}^{n} \delta_i \pi_{t-i} \ , \quad \sum_{i=1}^{n} \delta_i = 1. \tag{2}$$

Combining (1) and (2) yields:

$$\pi_t = \sum_{i=1}^{n} \delta_i \pi_{t-i} + \beta(u_t - u^*) + \gamma s_t + \epsilon_t \ , \quad \sum_{i=1}^{n} \delta_i = 1. \tag{3}$$

Equation (3) says that current inflation depends on past inflation, the unemployment rate, and a supply shock, where the coefficients on the past inflation rates sum to 1.

One restriction in Equation (3) is that the δ_i coefficients sum to one. A second restriction is that each price level is subtracted from the previous price level before entering the equation. These two restrictions are straightforward to test, and I have done so.[2] The test is simply to add π_{t-1} and p_{t-2} to equation (3) and see if they are significant, where p_t be the log of the price level for period t and $\pi_t = p_t - p_{t-1}$. The two variables are highly significant, which rejects the restrictions. This suggests that price equations should be specified using current and past price levels rather than current and past inflation rates.[3]

The long run effects on inflation from, say, a sustained 1.0 percentage point increase in the unemployment rate are obviously different depending on whether π_{t-1} and p_{t-2} are added to Equation (3). Dynamic results are presented in Fair (2021), and this discussion will not be repeated here. It is interesting to note that although the long run properties are quire different, the short run properties, out about eight quarters, are fairly similar. It is hard to distinguish among the equations based only on their short run properties, although the test above strongly rejects Equation (3).

The price equation that is used for the results below is discussed in Fair (2021), and again this discussion will not be repeated here. It is part of my US model, discussed in the next section. There is also a wage rate equation, where prices affect wages and vice versa. The equations are in log level form, consistent with the tests discussed above. The aggregate demand variable is the reciprocal of the unemployment rate ($1/UR$) rather than the level of UR, which the data support. The effect of the unemployment rate on the price level is thus nonlinear, larger at lower unemployment rates. More will be said about this below.

Some argue that the Phillips curve has become flatter over time. I have tested for the price equation used in this note whether the coefficient on $1/UR$ has changed over time, using rolling regressions all starting in 1954.1. I have found this not to be the case—see Fair (2021), p. 123. If, however, rolling regressions of, say, 20 years (80 quarters) are used, the coefficient estimate of $1/UR$ is smaller in absolute value in recent times. The problem with this procedure in my view is that the sample size is too small. As one rolls out of the mid-1980's, the inflation experience in the late 1960's, 1970's, and mid 1980's is lost, and one enters a much smoother period regarding inflation. Using 80 quarters and an end point of 2019.4, the last estimation period is 2000.1–2019.4, which is clearly not typical of the historical experience of inflation. It should not be surprising that price equations estimated for this period are considerably different from ones estimated earlier or for a longer period. Not using information through the 1980's is problematic. This sensitivity can be seen as follows. If for the 1954.1–2019.4 estimation period one adds the variable $D_t \cdot (1/UR_t)$ to the price equation, where D_t is 0 before 1990.1 and 1 from 1990.1 on, the coefficient estimate is small in absolute value and insignificant, with a t-statistic of -0.84. If, however, D_t is taken

[1] Some specifications take u^* to be time varying.

[2] The original tests are in Fair (2000). See (Fair 2021) for the latest results.

[3] "Price level" will be used to describe p even though p is actually the log of the price level.

to be 0 before 2000.1 and 1 from 2000.1 on, the coefficient estimate is significant with a t-statistic of − 3.93. Again, I interpret this as a small-sample problem.

A widely cited price deflator in the media is the price deflator for personal consumption expenditures. This is the price deflator targeted by the Fed. If, however, one is interested in explaining the pricing behavior of agents in the U.S. economy, this deflator is not appropriate because it includes import prices (as well as excluding export prices). The same is true of the Consumer Price Index. Import prices reflect decisions of foreign agents and the behavior of exchange rates, which are not decision variables of domestic agents. The price deflator used in the price equation here is the price deflator of the U.S. firm sector (*PF*), which reflects private, domestic decisions.

4 The US Model

To estimate interest rate effects on aggregate demand, one needs a whole model. My U.S. macroeconometric model, denoted the US model, will be used for this purpose. The model is described in detail in a document on my website, "Macroeconometric Modeling: 2018," which will be abbreviated "MM". Most of my past macro research, including the empirical results, is in MM. It is too much to explain the model in this note, and I will rely on MM as the reference. Think of MM as the appendix to this paper. In what follows the relevant sections in MM will be put in brackets. The price and wage equations discussed in the previous section are also discussed in MM.

The main estimated equations in the US model are four household expenditure equations (services, nondurables, durables, and housing), four labor supply equations (labor force participation of men 25–54, women 25–54, all others 16 +, and number of people holding two jobs (moonlighters)), plant and equipment and inventory investment equations, two labor demand equations (jobs and hours worked per job), an import demand equation, two term structure of interest rate equations (a bond rate and a mortgage rate), and the two price and wage rate equations mentioned above. There is also an estimated Fed interest rate rule, although, as discussed below, this equation is not used for purposes of this note.

Interest rates appear as explanatory variables in the four household expenditure equations, and this is the way monetary policy affects aggregate demand in the model. No interest rate effects could be found in the plant and equipment investment equation. When the short term interest rate in the model (*RS*) changes, this changes the bond rate and the mortgage rate through the term structure equations, which then affect household expenditures. The term structure equations are estimated under the constraint that, say, a sustained 1.0 percentage point increase in *RS* results in the long run in a 1 percentage point increase in the long rate. This constraint is supported by the data.

The estimation period is 1954:1–2019:4, and the estimation technique is two stage least squares (2SLS). The estimation accounts for possible serial correlation of the error terms. The variables used for the first stage regressors are the main exogenous and lagged endogenous variables in the model. A main issue regarding the consistency of the coefficient estimates in a structural equation is whether the first stage regressors are correlated with the error term in the equation. To guard against this, only lagged values of the exogenous variables are used as first stage regressors. This avoids the possibility that what is taken in the model to be an exogenous variable is in fact contemporaneously correlated with the error term in the equation. Also, the wealth variables, which appear in the structural equations with a lag of one quarter, are treated as endogenous. In a given equation the wealth variable lagged two quarters is used as a first stage regressor in the estimation. This avoids the possibility that the wealth variable lagged one quarter is correlated with the current error term in the structural equation. More will be said about this below.

The US model follows what I call the Cowles Commission (CC) approach. Theory is used to guide the choice of left-hand-side and right-hand-side variables for the stochastic equations in a model, and the resulting equations are estimated using a consistent estimation technique like 2SLS. Some argue that models specified using the CC approach are ad hoc, but this is not the case. Behavioral equations of economic agents are postulated and estimated. The CC approach has the advantage of using theory while keeping close to what the data say. See [MM, 1.1].

The CC methodology differs substantially from that behind the specification of DSGE models. For these models the theory is much tighter, rational expectations is assumed, and there is considerable calibration. These differences are discussed in Fair (2020), which also summarizes some of the main results from my macroeconometric modeling—empirical points that should be taken into account in constructing macro models.

The qualitative properties of the model regarding an increase in *RS* are the following. *RS* increases, the bond and mortgage rates increase through the term structure equations. The increase in interest rates lowers household expenditures, which lowers aggregate sales and aggregate output. Jobs and hours per job are lower because of the lower output, which leads to an increase in the unemployment rate (*UR*). The increase in *UR* leads to a decrease in the non farm price deflator (*PF*), and thus inflation (*PCPF*), through the price and wage equations.

The key quantitative issues are the following. How much do household expenditures fall? How much does *UR* rise in response to the fall in output? How much does *PF* fall in response to the rise in *UR*? In the short run output falls less than sales because there is an increase in inventory investment through the inventory investment equation. The percent decrease in jobs is less than the percent decrease in output because there is an increase in excess labor on hand through the jobs equation. There is a decrease in the number of moonlighters through the moonlighter equation, which leads to a smaller decrease in the number of people employed relative to the number of jobs. There is a decrease in the labor force through the three labor force participation equations because of estimated discouraged worker effects. The increase in *UR* is thus smaller than it would be if there were no fall in the labor force. There are thus a number of slippages from the decrease in aggregate sales to the increase in *UR*. Another property to keep in mind is that the effect of *UR* on *PF* depends on the level of *UR* because the explanatory variable in the price equation is $1/UR$. The next section presents the quantitative results. The above qualitative discussion is simplified because it ignores simultaneous effects, which are in the model. The quantitative results incorporate all effects. A few more points about the model.

There is an estimated Fed rule in the model, explaining *RS*, a rule I first estimated in 1978—(Fair 1978). This rule essentially stopped being relevant in 2008 when the Fed lowered the interest rate to near zero. This equation is in the model, estimated through 2008.3, but it is only for historical analysis. It has not been used for this note, and *RS* has been taken to be exogenous.

A variable in the model is the change in the value of household equity holdings due to equity price changes. The ratio of this variable to a measure of nominal potential output has been taken to be exogenous for the results in this note. For ease of exposition, call this variable the "change in stock prices." Regarding the exogenous assumption, one question is whether there are variables can be found that help explain the change in stock prices? It is the case that if the Fed makes a surprise announcement or if there is a surprise announcement that leads people to believe this will affect Fed behavior, there will be essentially an immediate change in stock prices (and bond prices). But on a quarterly basis there is little evidence that the change in stock prices can be explained by interest rates or any other variables. Rossi (2021), Section 2.3, has a review of attempts to explain asset-price changes, and there is no systematic positive evidence.[4]

[4] Each year I give one of my classes an assignment to explain the quarterly log change in the S&P 500 index since 1954 using any set of macro variables they want. Nothing sensible is ever found. There may be some explanatory power in predicting future stock prices or stock returns at long horizons. See, for example, (Greenwood and Shiefer 2014) and references therein. The lack of explanatory power at quarterly frequencies is what is relevant for this paper since it is concerned only with business cycle frequencies.

The argument here is thus that while there are clearly immediate effects on the change in stock prices from surprise announcements, the cumulation of these effects is not large enough to show up in quarterly data. The change in stock prices is largely unpredictable.

A second question about the exogenous assumption regarding the change in stock prices is whether there are unobserved forces that affect, say, both stock prices and household expenditures. Say there is a change in consumer mood (a shock) in quarter $t-1$ that negatively affects both stock prices and household expenditures in quarter $t-1$. And say this change persists for a number of quarters, thus affecting both stock prices and expenditures for quarters t, $t+1$, $t+2$, ... This would mean that wealth in quarter $t-1$ is correlated with the error term in an expenditure equation in quarter t. This would then bias the estimate of the coefficient of a one-quarter-lagged wealth variable in an expenditure equation if it were treated as exogenous in the 2SLS estimation. In other words, the wealth effect would be overestimated. At noted above, to at least partly account for this in the 2SLS estimation, an explanatory one-quarter-lagged wealth variable was treated as endogenous, with one of the first stage regressors being the two-quarter-lagged wealth variable. In other words, the two-quarter-lagged wealth variable is used as an instrument for the one-quarter-lagged wealth variable (along with the other first stage regressors). This leads to consistent coefficient estimates, other things being equal, if the shock lasts only two quarters. The implicit assumption in the model is thus that shocks from unobserved forces that affect both stock prices and household expenditures last no more than half a year. One justification for this assumption is that if the shocks were large and persistent for many quarters, one should be able to find this effect in the quarterly data. Lagged stock prices and current household expenditures are, of course, positively correlated because lagged wealth affects household expenditures.

5 Results

5.1 The Baseline Forecast

The quantitative estimates require a baseline forecast. A forecast was run using the US model and the NIPA data for 2021.4 that were released on January 27, 2022. The forecast period is 2022.1–2025.4, although only the results for the first eight quarters are reported here. This forecast is discussed on my website, and the reader is referred to the website for the details. The forecast uses when necessary actual values from 2021.4 back, but the model is estimated only through 2019.4 to avoid the pandemic observations. This forecast is based on the assumption that the Fed will raise *RS* by 50 basis points in each quarter of 2022 to reach

2.0 percent by the end of 2022. The rate is then assumed to remain at 2.0 after that.

Because the unemployment rate enters the price equation nonlinearly (as $1/UR$), the size of the effects of a change in *UR* on inflation depend on the baseline unemployment rates. The smaller is *UR*, the larger will be the effects on inflation from a given change in *RS*. The unemployment rate forecasts for the eight quarters are, respectively, 3.8, 3.5, 3.2, 3.0, 3.0, 3.1, 3.3, and 3.5. These values are quite low as the model is forecasting robust growth due in part to the lingering effects of the stimulus bills and strong wealth effects from housing and equity values. The growth rates (annual rates) of real output in the eight quarters are 4.2, 6.7, 6.0, 3.8, 2.7, 2.1, 1.9, and 1.6 percent, respectively. The predicted inflation rates are 3.9, 4.8, 5.6, 6.0, 6.0, 5.7, 5.2, and 4.8, respectively. If, of course, the Fed thought that these would be the inflation rates, it would likely raise interest rates more than is assumed for the forecast in order to lower inflation. The main point of this note is to estimate how much power it has to do this.

For a macroeconometric model like the US model there is much more uncertainty about the accuracy of a forecast than about the accuracy of the size of policy effects. The variances of estimated multiplier effects are generally much smaller than the variances of forecast errors. Fortunately, the interest in this note is on the policy effects. Although the model is nonlinear, it doesn't matter much what the baseline is except for the level of the unemployment rate as mentioned above. This is discussed in more detail below.

5.2 Estimated Unemployment Rate Effects on Inflation

It will first be useful to examine the size of the unemployment rate effects on inflation. This experiment uses just the price equation and the wage equation in the model, so the endogeneity of the unemployment rate is ignored. The experiment is to increase *UR* by 1.0 percentage points from baseline each quarter and to see how much inflation decreases. Two experiments were run, one using the baseline unemployment rates listed above and one using 4.0 for each of the eight quarters. The results are in Table 2.

Table 2 shows that using the forecast baseline unemployment rates inflation is down by 1.7 percentage points after five quarters. Using the 4.0 baseline, inflation is down 1.0 percentage points. The nonlinear effects at low unemployment rates are thus fairly large. The rest of this note will use the forecast baseline unemployment rates. This is the best case for the Fed. If it turns out that the unemployment rates are higher than forecast, the Fed's effect on inflation would be estimated to be smaller.

Table 2 Effects of a 1.0 Increase in *UR* on Inflation. Change from Baseline. Percentage Points

Qtr.	Forecast Baseline *UR* *PCPF*	4.0 Baseline *UR* *PCPF*
2022.1	− 1.5	− 1.4
2022.2	− 1.6	− 1.2
2022.3	− 1.8	− 1.2
2022.4	− 1.9	− 1.1
2023.1	− 1.7	− 1.0
2023.2	− 1.5	− 0.9
2023.3	− 1.2	− 0.8
2023.4	− 0.9	− 0.8

Table 3 Effects of a 1.0 Increase in *RS* from Baseline. *GDPR* and *JF*: Percent Change from Baseline. *UR* and *PCPF*: Change from Baseline. Percentage Points

Qtr.	*GDPR*	*JF*	*UR*	*PCPF*
2022.1	− 0.06	− 0.02	0.01	− 0.02
2022.2	− 0.16	− 0.06	0.04	− 0.09
2022.3	− 0.27	− 0.12	0.08	− 0.21
2022.4	− 0.37	− 0.19	0.13	− 0.34
2023.1	− 0.46	− 0.27	0.17	− 0.43
2023.2	− 0.52	− 0.34	0.20	− 0.44
2023.3	− 0.57	− 0.40	0.23	− 0.41
2023.4	− 0.60	− 0.46	0.24	− 0.35

5.3 Estimated interest rate effects on the unemployment rate and inflation

The next question is how much power does the Fed have in raising the unemployment rate and thus lowering inflation? An experiment was run in which *RS* was taken to be one percentage point higher than the forecast baseline, which remember is 0.5, 1.0, 1.5, and then 2.0. This experiment needs the entire model, which was used. Table 3 contains results for real output, jobs, *UR*, and inflation.

Table 3 shows that after five quarters *UR* is up 0.17 percentage points, real GDP is 0.46 percent lower, the number of jobs is 0.27 percent lower, and inflation is 0.43 percentage points lower. So it takes about a 4 or 5 percentage point increase in *RS* to raise *UR* by 1.0 percentage point after five quarters. Remember the slippages in the model from a decrease in aggregate sales to an increase in the unemployment rate: inventory investment, excess labor effects on jobs, decrease in moonlighters, and decrease in the labor force. These leakages lead to a smaller increase in *UR* than otherwise. Unlike in Table 2, the results in Table 3 are not sensitive to the baseline values of the unemployment rate except for the inflation values. Table 3 is to some extent the

Table 4 Effects of a Gradual Increase in *RS* from Baseline. *RS*, *UR*, and *PCPF*: Change from Baseline. *GDPR*: Percent Change from Baseline. Percentage Points

Qtr.	*RS*	*GDPR*	*UR*	*PCPF*
2022.1	1.0	− 0.06	0.01	− 0.02
2022.2	2.0	− 0.21	0.05	− 0.12
2022.3	3.0	− 0.48	0.14	− 0.35
2022.4	4.0	− 0.85	0.27	− 0.70
2023.1	5.0	− 1.31	0.44	− 1.05
2023.2	5.0	− 1.78	0.62	− 1.28
2023.3	5.0	− 2.18	0.80	− 1.37
2023.4	5.0	− 2.52	0.96	− 1.32

Table 5 Effects of a Gradual Increase in *RS* from Baseline. Gradual $10 Trillion Fall in Wealth. *RS*, *UR*, and *PCPF*: Change from Baseline. *GDPR*: Percent Change from Baseline. Percentage Points

Qtr.	*RS*	*GDPR*	*UR*	*PCPF*
2022.1	1.0	− 0.06	0.01	− 0.02
2022.2	2.0	− 0.26	0.08	− 0.17
2022.3	3.0	− 0.70	0.23	− 0.57
2022.4	4.0	− 1.36	0.83	− 1.18
2023.1	5.0	− 2.21	1.20	− 1.79
2023.2	5.0	− 3.06	1.55	− 2.14
2023.3	5.0	− 3.76	1.83	− 2.21
2023.4	5.0	− 4.28	2.03	− 2.07

main table in this note. It shows in a simple experiment the power of the Fed to affect inflation, which is less that many people seem to realize.

5.4 Phased-In Effects from the Baseline Forecast

The Fed usually phases in its interest rate changes, and it is of interest to examine this. An experiment was run in which *RS* was increased from baseline by 1.0 in 2022.1, 2.0 in 2022.2, 3.0 in 2022.3, 4.0 in 2022.4, and 5.0 in 2023.1. The change was then left at 5.0 from 2023.2 on. Since the baseline value of *RS* in 2023.1 and beyond is 2.0, the value of *RS* in 2023.1 and beyond is 7.0 in the experiment. One should focus, however, on the 5.0 change, not the 7.0 level. Similar results would be obtained if different baseline values of *RS* were used. Results are presented in Table 4 for real output, the unemployment rate, and inflation.

Table 4 shows that after eight quarters, which is three quarters after the phase in ends, output is down 2.52 percent from baseline, *UR* is 0.96 percentage points higher, and inflation is 1.32 percentage points lower. So this gradual, but large, interest rate increase by the Fed has led after eight quarters to about a 1.0 percentage

point increase in *UR* and a 1.3 percentage point decrease in inflation. The initial decreases in inflation are less in Table 4 than in Table 2 because the increase in *UR* in Table 2 was 1.0 percentage points from the beginning.

One more experiment is of interest. As discussed in Section 4, the change in stock prices has been taken to be exogenous. For the experiment in Table 4 the values of the change in stock prices are unchanged from baseline. Although on a quarterly basis no stable relationships appear to exist between the change in stock prices and any macro variables, including interest rates, it could be that stock prices permanently fall as the Fed tightens. To examine this case, the experiment in Table 4 was run under the assumption that the change in equity wealth is lower from baseline by $2.5 trillion in each of the four quarters of 2022, for a total decrease of $10 trillion in the value of household equity by the fourth quarter of 2022. This decrease in household wealth from baseline was then assumed to be sustained for the rest of the forecast period. This is a large and possibly extreme response of stock prices to Fed behavior, and it is assumed to be sustained.

The results are presented in Table 5. Wealth effects in the US model are large—see Fair (2019)—which are reflected in Tables 4 versus 5. In Table 5 after eight

quarters real output is 4.28 percent below baseline, *UR* is 2.03 percentage points above baseline, and inflation is 2.07 percent below baseline. In this case the Fed's policy of gradually raising *RS* by 5.0 percentage points has led to roughly a 2.0 percentage point fall in inflation at a cost of a 2.0 percentage point rise in *UR*. Although not shown in the table, by 2022.4 the number of jobs was 4.2 million below baseline and the number of people employed was 3.5 million below baseline. This experiment is likely extreme, but it gives a sense of wealth effects in the model. It is also made up in the sense that there is no estimated relationship between Fed behavior and the change in stock prices in the model.

6 Conclusion

The results using the US model show that the Fed's power to control inflation is modest and takes time. Although the price-wage equations show that there is a sizable response of inflation to the unemployment rate, especially at low values of the unemployment rate, the Fed's ability to increase the unemployment rate is limited. Short term interest rates have to be increased by 4 or 5 percentage points to increase the unemployment rate by 1 percentage point. The Fed is helped if there is a large stock market response to its policy changes, but there is no empirical evidence to support this on a quarterly basis.

Are the results in this note too pessimistic regarding the Fed's ability to lower inflation? They are, as just discussed, if there is a stock market response. Table 5 gives (perhaps extreme) estimates if this is the case. The results also are if the Fed can directly control inflation expectations, something that empirical results do not seem to support. They also are if there is a larger response of long term interest rates to changes in *RS* than is estimated in the term structure equations in the model. If the Fed engages in quantitative tightening (QT), this could lead to larger responses of long term rates to short term rates than is reflected in the term structure equations. The evidence is mixed on the effects of QT on long term rates relative to short term rates, but there could be at least some small effect here.

On the other hand, the results might be too optimistic in the following sense. Some have argued that Phillips curves have become flatter, so that it now takes a larger decrease in aggregate demand to lower inflation by a give amount than it did earlier. If a fairly flat Phillips curve is used in place of the price-wage equations in the US model, this is likely to lead to a smaller response of inflation to aggregate demand changes than estimated here. The Fed would have to work harder. Also, many Phillips curves are linear in aggregate demand, which may lead to a smaller response of inflation to changes in aggregate demand than estimated here because of the effects here of the low baseline values of the unemployment rate. Even given the model used here, if the predicted baseline unemployment rates turn out to be smaller than the actual values, the predicted decreases in inflation will be smaller.

Finally, it should be stressed that if one feels that the current increase in inflation will subside by itself with little Fed action, then the results in this note are not relevant. This note is relevant if one feels that some inflation will not go away and needs Fed help. How much help depends on how much one thinks inflation has to be lowered by the Fed.

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