

THE LABOR DEMAND AND LABOR SUPPLY CHANNELS OF MONETARY POLICY

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ABSTRACT. Monetary policy is conventionally understood to influence labor demand, with little effect on labor supply. Using high-frequency changes in interest rates around FOMC announcements and Fed Chair speeches, we find that contractionary monetary policy shocks lead to a significant increase in labor supply by reducing the rate at which workers quit jobs to non-employment and stimulating job-seeking behavior among the non-employed. Holding the response of supply-driven labor market flows fixed, the overall procyclical response of employment to monetary policy becomes nearly twice as large.

1. INTRODUCTION

“Policies to support labor supply are not the domain of the Fed: Our tools work principally on demand.” –Federal Reserve Chairman Jerome Powell, November 30, 2022

A consensus view among both policymakers and academics holds that monetary policy primarily influences labor demand and has little effect on labor supply. We offer new empirical evidence of a sizeable labor supply response to monetary policy. Using high-frequency identified monetary policy shocks from FOMC announcements and Fed Chair speeches, we show that a contractionary monetary policy shock generates quantitatively important increases in labor supply by decreasing the rate at which workers quit jobs to non-employment and stimulating job-seeking behavior among the non-employed. Thus, the decline in labor demand from a monetary policy tightening is partially offset by an increase in labor supply. Using a flow-based decomposition for labor market stocks, we show that a contractionary monetary policy shock decreases aggregate employment by almost twice as much when supply-driven labor market flows are held fixed.

To identify supply components of the labor market response to monetary policy shocks, we identify flows (and components of flows) that are driven by “labor supply” considerations: we classify flows between unemployment (U) and nonparticipation (N) as supply-driven, given that such flows occur when an individual decides to start

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or stop searching actively for work. Similarly, we classify quits to non-employment as supply-driven, given that such separations are initiated by the worker. Along the way, we provide new evidence that a large and procyclical component of flows between employment (E) and nonparticipation (N) is due to employee-initiated quits.

Then, borrowing from the “flows approach” to labor market aggregates, as in Davis, Faberman and Haltiwanger (2006), Shimer (2012), Elsby, Hobijn and Şahin (2015), and others, we express the evolution of employment, unemployment, and nonparticipation in terms of their initial values and subsequent labor market flows across these three states—that is, flows from E to N, E to U, N to E, N to U, etc. The overall responses of employment and unemployment to a monetary policy shock depend on the responses of each of these labor market flows. Thus, given our demarcation of “supply” based flows, we are able to compute the response of labor market aggregates to a monetary policy shock, holding labor supply flows fixed.

We begin our analysis by extending a standard monetary policy vector autoregression (VAR), such as Gertler and Karadi (2015) and Bauer and Swanson (2023b), to include labor market flows. We use high-frequency identification to estimate the effects of monetary policy on the economy and labor market, and we apply the methodology of Bauer and Swanson (2023b) to obtain better and more precise VAR estimates than the prior literature, including using speeches by the Fed Chair as well as FOMC announcements as sources of monetary policy variation.

Our VAR analysis shows that, not surprisingly, flows from E to U increase following a monetary policy tightening, and flows from U to E decrease, which are consistent with a weakening economy and lower labor demand. However, we also show that flows from N to U significantly *increase* following the monetary policy tightening, and flows from U to N decrease, which are consistent with an increase in labor *supply*. We thus find significant evidence that the conventional wisdom described above is not correct: monetary policy generates a considerable labor supply response. Intuitively, households might increase their labor supply in the face of a weakening economy in order to maintain their income and consumption; for example, when the primary earner of a household loses their job, additional household members may start looking for work to maintain total household consumption.

We extend our analysis in several directions to corroborate and better understand this finding. First, we verify that the estimated responses of these labor market flows are not driven by cyclical changes in the composition of the labor market, implying that the estimated response of labor market flows to monetary policy shocks reflect changes in labor supply at the individual level.

Second, we use additional survey data to produce a novel decomposition of separations to non-employment into components reflecting labor demand or labor supply. We show that a large proportion of flows from employment to unemployment (EU) and employment to nonparticipation (EN) can be categorized as either layoffs or quits to non-employment. While an existing literature decomposes EU flows into quits and layoffs, we are unaware of a similar analysis for EN flows. Whereas EU flows are dominated by layoffs, quits are a much more significant driver of EN transitions: we show that at least as many people quit employment to nonparticipation each month

as are laid off in total. Not only is the level of such quits significant, but the rate at which employed workers quit to nonparticipation is strongly procyclical, suggesting that such flows play a more important role in determining the dynamics of labor market aggregates than previously understood.

Then, we interpret layoffs as reflecting factors related to labor demand and quits to non-employment as reflecting factors related to labor supply. We find that layoffs rise persistently in response to a contractionary monetary policy shock, while quits to non-employment decline significantly, corroborating our finding of an increase in labor supply in flows between U and N. We find similar evidence of labor supply increases among the non-employed on the “intensive margin”: non-participants are more likely to report that they want a job, while unemployed individuals use more search methods to find work.

Third, we build on the methodology of Shimer (2012) and Elsby et al. (2015) to construct counterfactual impulse response functions for labor market aggregates that “shut down” each of the labor market flows in turn to assess their quantitative importance. We find that, holding the response of supply-driven labor market flows fixed, the response of employment to a contractionary monetary policy shock would be almost twice as large. This simple flow-based accounting framework highlights that the countercyclical labor supply response to monetary policy—manifested through lower quits to non-employment and greater job-seeking from non-employment—is of significant quantitative importance for understanding the transmission of monetary policy to labor market aggregates.

We also show that the employment response to monetary policy differs across subgroups of the population, with some groups showing quantitatively more important labor supply responses. Hence, the aggregate employment response to monetary policy depends on the composition of the labor force not only through differences in exposure to monetary policy-induced changes in labor demand, but also from cross-sectional differences in willingness to substitute away from leisure.

Thus, our decompositions reveal a quantitatively important role for labor supply in shaping the overall labor market response to monetary policy. Following the logic of similar exercises by Shimer (2012) and Elsby et al. (2015), our estimates suggest that models seeking to generate realistic employment responses to monetary policy should also be consistent with the response of supply-driven labor market flows that we estimate. Moreover, given the partial equilibrium nature of our decompositions, a general equilibrium model could yield additional insights on the importance of labor supply responses to monetary policy. For example, shutting down the countercyclical labor supply response to monetary policy could put upward pressure on wages and therefore enhance the total decline in labor demand. Such an effect on wages may also be an important channel through which monetary policy affects inflation. Thus, we believe that incorporating the labor supply response that we document here into New Keynesian models is an important topic for future research.

We take a first step in this direction by demonstrating the plausibility of our empirical results within a simple model of frictional labor markets with endogenous decisions to search from non-employment and to quit employment, as in Krusell et

al. (2017). Workers have strictly positive but diminishing marginal utility from consumption, derive utility from leisure, and face a fixed leisure cost of searching for a job. A contractionary monetary policy shock decreases job-finding probabilities and reduces consumption. As we show, the response of non-employed workers in the model accommodates both a substitution effect—where the reduction in job-finding rates induces workers to move from unemployment to nonparticipation—and also an income effect—where the increase in the marginal utility of consumption reduces the consumption-equivalent value of leisure and induces workers to move from nonparticipation to unemployment. To match our empirical estimates, the income effect must dominate. Thus, a model with frictional labor markets, an active participation decision, and sufficiently strong income effects is likely to be consistent with the data.

After surveying the related literature, the remainder of the paper proceeds as follows. In Section 2, we review the standard empirical measures of labor market stocks and introduce our decompositions of EU and EN flows as well as intensive margin measures of labor supply. We also discuss high-frequency identification of monetary policy VARs. In Section 3, we report our baseline empirical estimates of how labor market flows respond to a monetary policy shock. In Section 4, we compute the counterfactual impulse response functions when we shut down each of the labor market flows in turn. In Section 5, we present a simple model of labor market flows that demonstrates the relationship between monetary policy shocks and labor market supply. Section 6 concludes and discusses directions for future research. An Appendix provides additional details about the data and robustness of our results.

Related Literature. Our paper is related to several strands of the literature. First, we build on an extensive empirical literature on labor market flows and their implications for aggregate labor market variables like employment and unemployment (e.g., Davis, Faberman and Haltiwanger, 2006; Shimer, 2012; Elsby, Hobijn and Şahin, 2015). A primary and distinctive contribution of our paper comes from documenting the large and cyclical role of quits from employment to nonparticipation, which we show to be particularly important for understanding the cyclical dynamics of the employment-population ratio.

In terms of our focus on flows between unemployment and nonparticipation, we build on the work of Elsby, Hobijn and Şahin (2015). While they constrain their focus on the role of such flows in determining cyclical variation in the unemployment and labor force participation rates, we emphasize the contribution of flows between U and N to cyclical variation in the employment-population ratio. As we document, flows between U and N offer a quantitatively more important contribution to employment dynamics than to unemployment dynamics. We offer a further contribution in documenting the importance of quits from employment to nonparticipation as an additional supply-related flow.

We also show that flows from employment to unemployment (EU) are roughly as important as flows from unemployment to employment (UE) in driving the overall response of unemployment to a monetary policy shock. Our estimates here contrast with those of Shimer (2012), who concludes that UE flows are responsible for the

majority of the unconditional business cycle variation in unemployment.¹ Thus, in contrast to the Hall (2005)–Shimer (2005) modeling paradigm that abstracts from cyclical variation in separations (EU flows), our estimates suggest that they are an important margin for the response of labor markets to monetary policy.

Our paper joins the nascent literature studying the *conditional* responses of labor market flows to monetary policy shocks, which includes White (2018), Broer, Kramer and Mitman (2021), Coglianesi, Olsson and Patterson (2022), and Faia et al. (2022). There are three main advantages to the conditional approach: First, the conditional response of labor market flows to a single type of shock can provide insights that would be obscured in the unconditional setting, which mixes together the responses of labor market flows to technology shocks, monetary shocks, preference shocks, etc. For example, it would not be surprising if labor supply moved unconditionally or in response to a preference shock, while it is more surprising if it responds to a monetary policy shock. Second, the conditional responses of labor market flows to different shocks can similarly provide more stringent tests of a given model. For example, our finding of a labor supply response to a monetary policy shock presents a challenge for some labor search models to match. Third, knowing how labor market flows respond to a monetary policy shock improves our understanding of how monetary policy affects the economy, which is useful for monetary policymakers.

Our paper contributes to this developing literature by being the first to confront the “Fed Information” or “Fed Response to News” effect in our estimates of the conditional responses of labor market flows to a high-frequency monetary policy surprise. As discussed in Bauer and Swanson (2023a), high-frequency monetary policy surprises are correlated with economic news released shortly before the monetary policy announcement, which can introduce an attenuation bias in estimates of monetary policy’s true effects. Thus, when we estimate responses of labor market flows to “unadjusted” high-frequency surprises, we find only a weak response of employment-to-unemployment (EU) flows and no response of unemployment-to-employment (UE) flows (see Figure B.3). Once we orthogonalize the high-frequency surprises according to the procedure outlined in Bauer and Swanson (2023a,b), we recover stronger responses. However, the first-stage F -statistic falls dramatically, and so we encounter a weak instrument problem (see Figure B.4). Only once we incorporate orthogonalized high-frequency surprises from both FOMC announcements and Fed Chair speeches do we obtain a sufficiently high first-stage F -statistic to conduct meaningful inference.

Our paper is more broadly related to the literature on monetary policy VARs and high-frequency identification, such as Cochrane and Piazzesi (2002), Faust et al. (2003), Faust, Swanson and Wright (2004), Gertler and Karadi (2015), Ramey (2016), and Bauer and Swanson (2023b). In contrast to these papers, we extend our VAR to look at labor market flows in order to quantify the importance of different flows in shaping the response of labor market aggregates.

¹As we discuss, our findings are similar to those of Elsby et al. (2009) and Fujita and Ramey (2009), whose findings suggest a more important role for separations in explaining unconditional business cycle variation in unemployment.

Finally, our paper relates to a large literature studying New Keynesian DSGE models with sticky wages and a neoclassical labor market without search frictions, such as Christiano, Eichenbaum and Evans (2005), Smets and Wouters (2007), Auclert, Rognlie and Straub (2018) and Auclert, Bardóczy and Rognlie (2021). Such models require sticky wages to fit the data, implying that labor is demand-determined in the short run, and leaving little room for income effects on labor supply to influence employment.² A similar absence of a role for labor supply is reflected in the smaller literature studying New Keynesian models that incorporate equilibrium unemployment, but abstract from a participation margin, e.g., Gertler, Sala and Trigari (2008), Christiano, Eichenbaum and Trabandt (2016), and Graves (2022). In contrast to these papers, we impose minimal structure on the data to recover labor demand and supply responses to a monetary policy shock, and we find that changes in labor supply play an important role in shaping those responses.

2. DATA AND METHODOLOGY

To distinguish between the labor demand and labor supply effects of monetary policy, we extend a standard monetary policy VAR (e.g., Gertler and Karadi, 2015; Bauer and Swanson, 2023b) to include data on labor market flows. In addition—and key for our decompositions in Section 4—we will not only study flows between employment, unemployment and nonparticipation, but we will also distinguish the extent to which transitions away from employment are driven by labor supply considerations. We first describe the data.

2.1. Labor market stocks and flows. We study the cyclical behavior of aggregate labor market stocks and flows. Our primary data source for gross worker flows is the longitudinally linked data from the monthly Current Population Survey (CPS) from 1978 to 2019. We organize our discussion of labor market stocks and flows in terms of three distinct labor market states: employment (E), unemployment (U), and nonparticipation (N).

Table 1 presents summary statistics for three standard labor market stock measures—the employment-population ratio, $E/(E+U+N)$; the unemployment rate, $U/(E+U)$; and the labor force participation rate, $(E+U)/(E+U+N)$ —plus a fourth measure that we discuss shortly. The cyclical properties of these first three labor market aggregates are well known: the employment-population ratio is procyclical but not very volatile, the unemployment rate is countercyclical and highly volatile, and the labor force participation rate is only modestly procyclical and not very volatile.

The fourth labor market stock measure in Table 1 is what we call the non-employed search rate, $U/(U+N)$. The non-employed search rate describes the fraction of the non-employed that are actively searching for work. It is highly countercyclical and nearly as volatile as the unemployment rate. In the language of Mukoyama et al. (2018), this rate is the “extensive margin” of job search activity. This measure will

²For an informative discussion of the role of wage stickiness in the New Keynesian transmission mechanism see Broer et al. (2020).

TABLE 1. Cyclicalities of Labor Market Stocks

	Employment- population ratio	Unemployment	Labor force participation	Non-employed search rate
mean(x)	61.14	6.19	65.16	10.30
std(x)/std(Y)	0.72	8.26	0.23	7.13
corr(x, Y)	0.83	-0.85	0.35	-0.84

Note: x denotes the variable in each column, Y denotes HP-filtered log real GDP. Standard deviations and correlations in the second and third rows are computed for HP-filtered quarterly averages. We define the non-employed search rate as the share of unemployed individuals in the non-employed.

feature prominently in our analysis as a reflection of the cyclicalities of the value that non-employed workers place on employment.

The dynamic behavior of the labor market stocks —E, U, and N—can be understood by the flows of workers across these three states. Labor markets exhibit considerable churn, with positive gross flows in both directions between any two labor market states. Let $p_{X,Y}$ denote the fraction of workers in labor market state X moving to state Y . Labor market stocks and flows are then related by the Markov process:

$$\begin{bmatrix} E \\ U \\ N \end{bmatrix}_{t+1} = \begin{bmatrix} 1 - p_{EU} - p_{EN} & p_{UE} & p_{NE} \\ p_{EU} & 1 - p_{UE} - p_{UN} & p_{NU} \\ p_{EN} & p_{UN} & 1 - p_{NE} - p_{NU} \end{bmatrix}_{t+1} \begin{bmatrix} E \\ U \\ N \end{bmatrix}_t. \quad (1)$$

Equation (1) can be extended to study the dynamics of labor market stocks across longer time periods. Let P_{t+1} denote the transition matrix in equation (1). Given the vector $[E, U, N]_t'$ and a time series of transition matrices $\{P_{t+j}\}_{j=1}^k$, we can express labor market stocks at $t + k$ as

$$\begin{bmatrix} E \\ U \\ N \end{bmatrix}_{t+k} = \left(\prod_{j=1}^k P_{t+j} \right) \begin{bmatrix} E \\ U \\ N \end{bmatrix}_t. \quad (2)$$

Thus, given an initial condition, we can understand the dynamic properties of labor market stocks through the time series of labor market transitions. In Section 4, we use this relationship to help understand how shifts in supply-driven labor market flows account for the response of labor market stocks to monetary policy surprises.

Table 2 reports the average labor market transition matrix \bar{P}_t estimated over our sample, 1978–2019.³ Table 3 summarizes the cyclical properties of each of the six HP-filtered off-diagonal transition probabilities. The full time series of transition

³We seasonally adjust each flow using the X-13ARIMA-SEATS seasonal adjustment software provided by the Census Bureau. Given our subsequent focus on quits and layoffs from non-employment, we do not adjust for time aggregation bias. All our results are robust to corrections for time aggregation, where such corrections are possible.

TABLE 2. Average Transition Probabilities Across Labor Market States

<i>From</i>	<i>To</i>		
	E	U	N
E	0.954	0.014	0.030
U	0.255	0.483	0.227
N	0.046	0.025	0.926

TABLE 3. Cyclicalities of Labor Market Flows

	p_{EU}	p_{EN}	p_{UE}	p_{UN}	p_{NE}	p_{NU}
mean	0.014	0.030	0.255	0.227	0.046	0.025
std(x)/std(Y)	5.43	2.40	5.71	4.16	2.84	5.26
corr(x , Y)	−0.81	0.51	0.78	0.71	0.66	−0.67

Note: x denotes the variable in each column, Y denotes HP-filtered log real GDP. Standard deviations and correlations in the second and third rows are computed for HP-filtered quarterly averages.

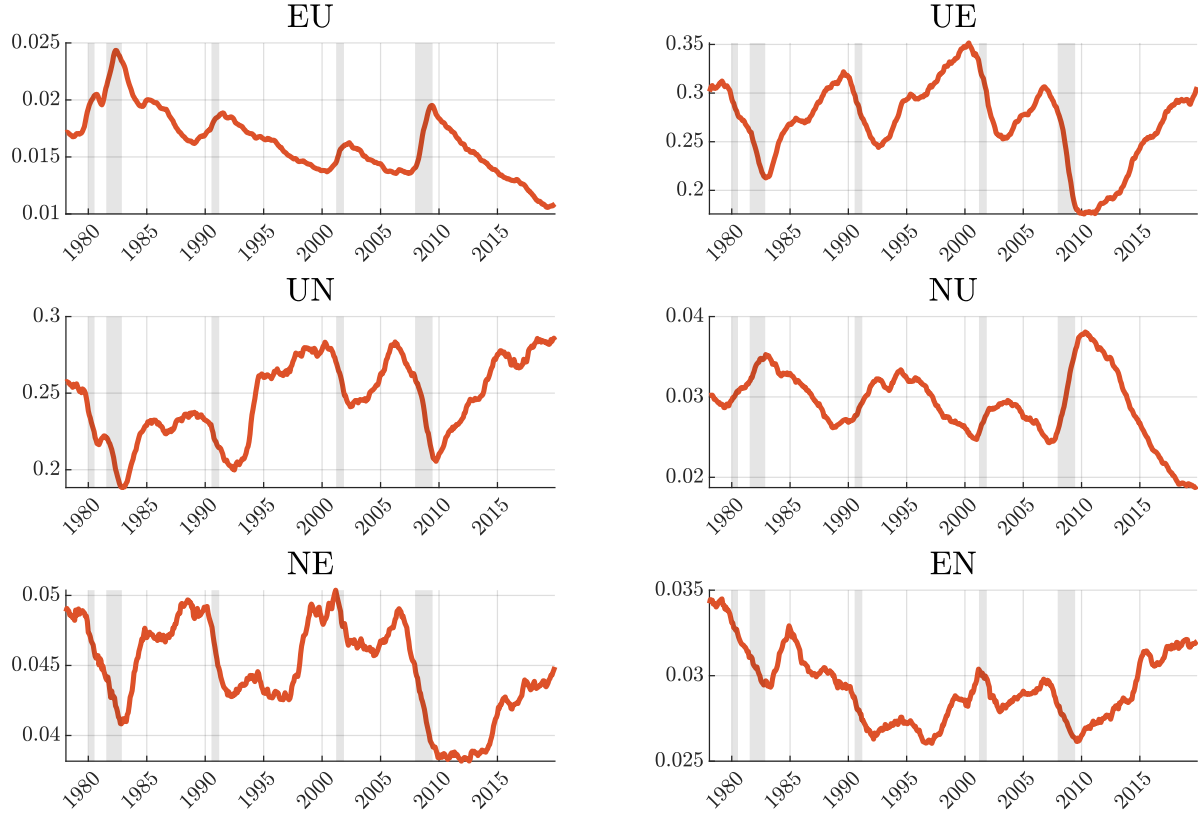
probabilities for our sample is plotted in Figure 1.⁴ The properties of these transition probabilities have been well documented in the literature (e.g., Shimer, 2012; Elsby et al., 2015; Krusell et al., 2017). Here we simply note that we will consider flows between nonparticipation and unemployment as being driven by labor supply considerations. The procyclicality of UN flows and countercyclicality of NU flows is evidence of greater job-seeking behavior among the non-employed during downturns. Elsby et al. (2015) show that this accounts for about one-third of fluctuations in the unemployment rate.

Movements between unemployment and nonparticipation are not the only place where we identify a significant role for labor supply responses. In the next section, we decompose EU and EN flows in a way that allows us to distinguish the extent to which they are driven by labor demand vs. labor supply forces. Doing so will also shed light on the finding that EU flows are strongly countercyclical while EN flows are procyclical.

2.2. Decompositions of Separations into Quits and Layoffs. To understand the roles of labor demand and labor supply in driving EU and EN transitions, we decompose EU and EN flows into “quits”, “layoffs” and “other separations”. We perform this decomposition using the additional survey detail that is provided in the CPS—for example, if a worker transitioning from E to U lists the reason for unemployment in the CPS as being a “job leaver”, then we classify that transition as

⁴For visual clarity, all plots of raw data are smoothed using a 12-month moving average filter. All calculations are done on the raw data.

FIGURE 1. Labor Market Flows

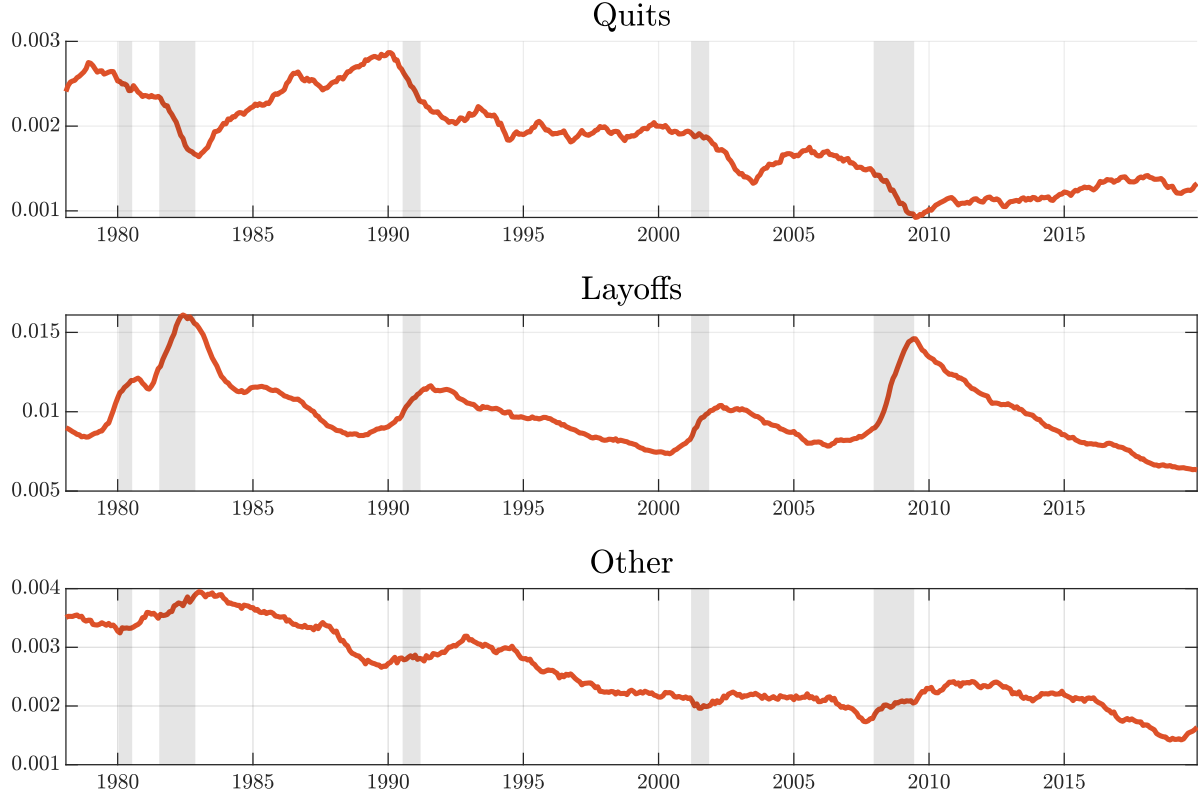


a quit, while if they report being a “job loser/on layoff”, we classify that transition as a layoff. Additional details are provided in Appendix A.1. We interpret layoffs as being driven by factors related to labor demand and quits as being driven by factors related to labor supply. Having this decomposition will be important when we want to shut down labor supply forces in Section 4.

Figure 2 shows the time series of EU flows for quits, layoffs, and other separations, and Table 4 summarizes their cyclical properties. About 70% of EU flows are due to employer-initiated separations, i.e. layoffs. Such EU flows are highly countercyclical and volatile. Another 10-15% are due to voluntary quits; such EU flows are similarly volatile, but are instead procyclical. The remaining 15-20% of EU flows that cannot be categorized as quits or layoffs are only weakly countercyclical.

Thus, our analysis of EU flows suggest that workers are less likely to quit a job to unemployment during a recession, but are more likely to be fired. Since layoffs account for the majority of EU flows, the overall cyclicity of the EU rate is driven

FIGURE 2. Decomposition of Employment-to-Unemployment Flows



Note: Employment-to-unemployment flows are decomposed into quits, layoffs and other separations as explained in Appendix A.1.

TABLE 4. EU Components

	Total	Quits	Layoffs	Other
mean	0.014	0.002	0.010	0.003
std(x)/std(Y)	5.16	8.16	7.88	6.26
corr(x , Y)	-0.82	0.61	-0.83	-0.11

Note: The process for decomposing EU flows into quits, layoffs and other separations is described in Appendix A.1. Standard deviations and correlations in the second and third rows are computed for HP-filtered quarterly averages.

TABLE 5. EN Components

	Total	Quits	Layoffs	Other
mean	0.030	0.012	0.003	0.015
$\text{std}(x)/\text{std}(Y)$	2.47	5.89	14.46	4.61
$\text{corr}(x, Y)$	0.49	0.53	-0.44	0.28

Note: The process for decomposing EN flows into quits, layoffs and other separations is described in Appendix A.1. Standard deviations and correlations in the second and third rows are computed for HP-filtered quarterly averages.

by countercyclicality of layoffs. Such properties of EU flows have been documented elsewhere in the literature, e.g., Elsby et al. (2009) and Ahn (2023).

Although a considerable literature studies the cyclicity and composition of EU flows, employment outflows to unemployment are substantially smaller than employment outflows to nonparticipation, as shown in Table 2. Thus, in Figure 3 and Table 5, we provide a similar decomposition of EN flows into layoffs, quits and other separations.⁵ As was the case for EU flows, EN layoffs are countercyclical and EN quits are procyclical. But, whereas layoffs comprise a large fraction of identifiable EU flows, EN flows show a more dominant role for quits. This finding of the quantitative significance of quits to nonparticipation stands in direct contrast with much of the literature, e.g. Faberman and Justiniano (2015), which often equates quits with job-to-job transitions. We show that just because few people quit to unemployment, it is not necessarily the case that few people quit to non-employment.⁶

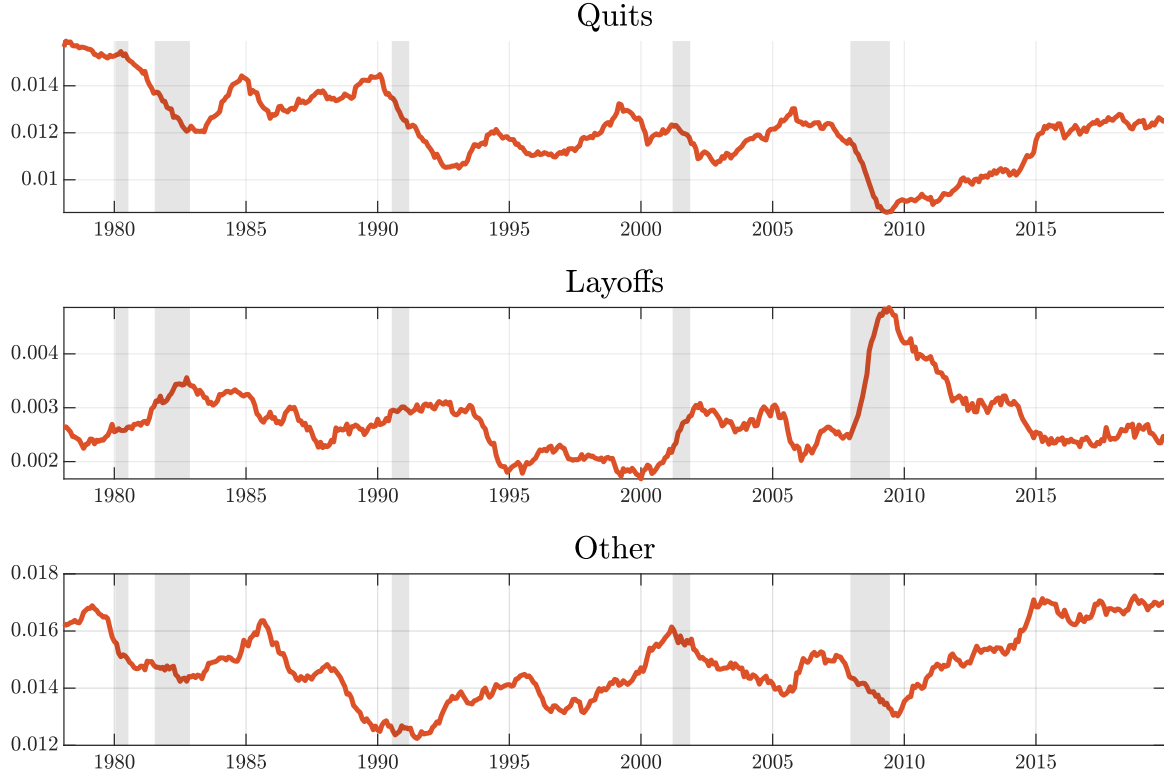
Hence, the observed procyclicality of EN flows can be accounted for by the tendency of workers to quit to nonparticipation rather than to unemployment. The portion of EN flows that can be identified as quits is economically significant and of similar magnitude to the entirety of EU flows.

Our findings of procyclical quits to non-employment offer further evidence of the importance of labor supply. Note, whereas the decomposition of EU flows into quits and layoffs has been provided elsewhere in the literature, we are unfamiliar of a similar decomposition of EN flows as we provide here. Our findings document a much more important role for both the magnitude and cyclicity of quits to non-employment than has been previously recognized.

⁵As we discuss in Appendix A.1, a larger fraction of EN transitions cannot be categorized (individuals classified as retired or disabled are a significant portion of this category). The cyclical behavior of such uncategorized EN flows is similar to that of quits to nonparticipation.

⁶Faberman and Justiniano (2015) explain their use of the JOLTS quit rate as a proxy for the job-to-job transition rate from the finding of Elsby et al. (2010) that only 16% of quits lead to unemployment. Our findings suggest that a large fraction of JOLTS quits may reflect quits to nonparticipation rather than job-to-job transitions.

FIGURE 3. Decomposition of Employment-to-Nonparticipation Flows



Note: Employment to non-employment flows are decomposed into quits, layoffs, and other separations as explained in Appendix A.1.

Finally, our results could be considered surprising in light of a prominent view summarized by Shimer (2012): Under efficient separations à la Barro (1977) where wages are not allocative, the distinction between quits and layoffs is economically irrelevant. Why, then, do we find differential cyclical behavior of quits and layoffs?

Suppose instead that wages for continuing workers are sticky, so that they cannot be sufficiently cut during a recession (to prevent a layoff) or increased during an expansion (to prevent a quit). Then, the findings summarized in Tables 4 and 5 documenting countercyclical layoffs and procyclical quits to non-employment should come as no surprise. Such an interpretation of separations could also explain the predominance of quits among EN flows and layoffs among EU flows: to the extent that workers recently laid-off from a job still want work, they should be expected to be found among the unemployed. Similarly, to the extent that quits to non-employment reflect a reduction in the desire to work, workers quitting to non-employment should be expected to be found among non-participants. Thus, our findings are consistent with a more recent literature documenting inefficient separations and an allocative

FIGURE 4. Intensive Margins of Labor Supply



Note: We calculate the probability of non-participants that want a job and the number of search methods of the unemployed using the procedure described in Appendix A.2.

role for wages along the separation margin, e.g. Jäger et al. (2022) and Davis and Krolkowski (2022).

2.3. The Intensive Margin of Labor Supply. In Section 2.3 we documented the countercyclicality of job-seeking behavior of the non-employed on the extensive margin: the decision of whether or not to actively search for a job. This increased search rate from non-employment may be interpreted as evidence that the non-employed place greater value on finding a job during a downturn. We are able to offer additional evidence in support of this interpretation by analyzing “intensive margins” within nonparticipation and unemployment that may affect the rate at which the non-employed find work.

We first study the time series behavior for the fraction of non-participants wanting a job despite not being engaged in active search, shown in the top panel of Figure 4. During recessions, the fraction of workers in nonparticipation who express a desire for

work increases markedly and persistently. This increase in the desire to work among nonparticipants is economically relevant for understanding overall labor flows: while the rate at which workers in N move to E is five times smaller than that of workers in U, the rate at which workers in N *who want work* move to E is just over half that of workers in U.

Next, we study the number of active search methods of workers in U as a measure of search intensity. Such a measure has been used elsewhere in the literature to show that search is countercyclical, including Osberg (1993), Shimer (2004), and Mukoyama et al. (2018). Mukoyama et al. (2018) go further, showing from the American Time Use Survey (ATUS) that time spent searching for a job is essentially linear in the number of search methods. Relative to these papers, we construct a consistent measure of the number of search methods starting from 1978 rather than 1994, shown in the bottom panel of Figure 4. To the extent that active search is costly but increases the probability of finding a job, these findings offer further evidence that workers place greater value on employment during periods of slack labor market activity.⁷

2.4. Monetary Policy VARs and High-Frequency Identification. Several recent papers have used high-frequency interest rate changes around the Federal Reserve’s Federal Open Market Committee (FOMC) announcements, or *monetary policy surprises*, to estimate the effects of monetary policy in a VAR (e.g., Cochrane and Piazzesi, 2002; Faust et al., 2003, 2004; Stock and Watson, 2012, 2018; Gertler and Karadi, 2015; Ramey, 2016; Bauer and Swanson, 2023b). Monetary policy surprises are appealing in these applications because their focus on interest rate changes in a narrow window of time around FOMC announcements plausibly rules out reverse causality and other endogeneity problems, as we discuss below. We will study the labor supply response to monetary policy in part by extending such a VAR to include the labor market flow variables described above.

The core of our VAR includes six monthly macroeconomic variables: the log of industrial production, the unemployment rate, the labor force participation rate, the log of the consumer price index, the Gilchrist and Zakrajšek (2012) excess bond premium, and the two-year Treasury yield.⁸ This specification is very similar to Bauer and Swanson (2023b), except that we include labor force participation as an additional variable, given our focus on the labor market. We stack these six variables into a vector Y_t and estimate the reduced-form VAR,

$$Y_t = \alpha + B(L)Y_{t-1} + u_t, \quad (3)$$

⁷Huckfeldt (2023) shows that the probability of finding a job is increasing in number of search methods.

⁸Industrial production, the unemployment rate, labor force participation rate, the CPI, and the two-year Treasury yield are from the Federal Reserve Bank of St. Louis FRED database. We include the GZ credit spread for consistency with Bauer and Swanson (2023b) and because Caldara and Herbst (2019) found it to be important for the estimation of monetary policy VARs. As discussed in Swanson and Williams (2014) and Gertler and Karadi (2015), the two-year Treasury yield was largely unconstrained during the 2009–15 zero lower bound period, making it a better measure of the overall stance of monetary policy than a shorter-term interest rate like the federal funds rate.

where α is a constant, $B(L)$ a matrix polynomial in the lag operator, and u_t is a 6×1 vector of serially uncorrelated regression residuals, with $\text{Var}(u_t) = \Omega$. We estimate regression (3) from February 1978 to December 2019 via ordinary least squares with 6 monthly lags.

We follow standard practice and assume that the economy is driven by a set of serially uncorrelated structural shocks, ε_t , with $\text{Var}(\varepsilon_t) = I$ (see, e.g., Ramey, 2016). Since the dynamics of the economy are determined by $B(L)$, the effects of different structural shocks ε_t on Y_t are completely determined by differences in their impact effects on Y_t in period t —that is, by their effects on u_t ,

$$u_t = S\varepsilon_t, \quad (4)$$

which we assume are linear, with S a matrix of appropriate dimensions. We assume that one of the structural shocks is a “monetary policy shock”, and we order that shock first in ε_t and denote it by ε_t^{mp} . The first column of S , denoted s_1 , then describes the impact effect of the structural monetary policy shock ε_t^{mp} on u_t and Y_t .

To identify the impact effect s_1 of the monetary policy shock ε_t^{mp} , we use high-frequency identification: Let z_t denote our set of high-frequency interest rate changes (monetary policy surprises) around FOMC announcements and Fed Chair speeches, converted to a monthly series by summing over all the high-frequency surprises within each month.⁹ In order for z_t to be a valid instrument for ε_t^{mp} , it must satisfy an instrument *relevance* condition,

$$E[z_t \varepsilon_t^{mp}] \neq 0, \quad (5)$$

and an instrument *exogeneity* condition,

$$E[z_t \varepsilon_t^{-mp}] = 0, \quad (6)$$

where ε_t^{-mp} denotes any element of ε_t other than the first (Stock and Watson, 2012, 2018).

The appeal of high-frequency monetary policy surprises is that they very plausibly satisfy conditions (5)–(6). First, FOMC announcements and Fed Chair speeches are an important part of the news about monetary policy each month, so the correlation

⁹High-frequency interest rate changes around FOMC announcements and Fed Chair speeches are from the dataset constructed by Swanson and Jayawickrema (2023), which includes all 323 FOMC announcements from 1988 to 2019 and all 404 press conferences, speeches, and Congressional Testimony by the Fed Chair (which we refer to as “speeches” for brevity) over the same period that had potential implications for monetary policy, according to the financial market commentary in the *Wall Street Journal* or *New York Times*. This is somewhat larger than the set of announcements used by Bauer and Swanson (2023b), who worked with an earlier version of the dataset that contained only the 295 most influential Fed Chair speeches. We compute z_t in exactly the same way as Bauer and Swanson (2023b), taking the first principal component of the change in the current-quarter and 1-, 2-, and 3-quarter-ahead Eurodollar future rates in a narrow window of time around each FOMC announcement and Fed Chair speech. Including Eurodollar futures out to a horizon of about 1 year implies that our monetary policy surprise measure captures changes in the Fed’s forward guidance as well as changes in the current federal funds rate.

between z_t and ε_t^{mp} in (5) should be positive and large.¹⁰ Importantly, including Fed Chair speeches provides us with a *much* more relevant instrument than using FOMC announcements alone, as shown by Bauer and Swanson (2023b). Second, high-frequency monetary policy surprises capture interest rate changes in narrow windows of time around policy announcements. It’s therefore unlikely that other structural shocks in ε_t^{-mp} are significantly affecting financial markets at the same time, so that these other shocks should be uncorrelated with z_t , implying (6).¹¹

Given our external instrument z_t , we estimate the impact effects s_1 in the SVAR as described in Stock and Watson (2012, 2018), Gertler and Karadi (2015), and Bauer and Swanson (2023b). For concreteness, order the two-year Treasury yield first in Y_t , and denote it by Y_t^{2y} . We then estimate the regression

$$Y_t = \alpha + B(L)Y_{t-1} + s_1 Y_t^{2y} + \tilde{u}_t \quad (7)$$

via two-stage least squares, using z_t as the instrument for Y_t^{2y} .¹² It is straightforward to show that (5)–(6) imply this regression produces an unbiased and consistent estimate of s_1 , with the first element normalized to unity. (In our empirical results below, we rescale s_1 so that the first element corresponds to an impact effect of 25 basis points, rather than 1 percentage point.)

Finally, following the prescriptions of Bauer and Swanson (2023a,b), we adjust our high-frequency instrument z_t by projecting out any correlation with recent macroeconomic and financial news. As Bauer and Swanson (2023a,b) show, this purges our VAR estimates of any “Fed Information” or “Fed Response to News” effects that might otherwise contaminate our estimates.

3. ESTIMATES

Estimated impulse response functions (IRFs) from the baseline monetary policy VAR described above are presented in Figure 5. The solid black line in each panel reports the IRF, while dark- and light-blue-shaded regions report bootstrapped 68% and 90% standard error bands, computed as in Jentsch and Lunsford (2019).

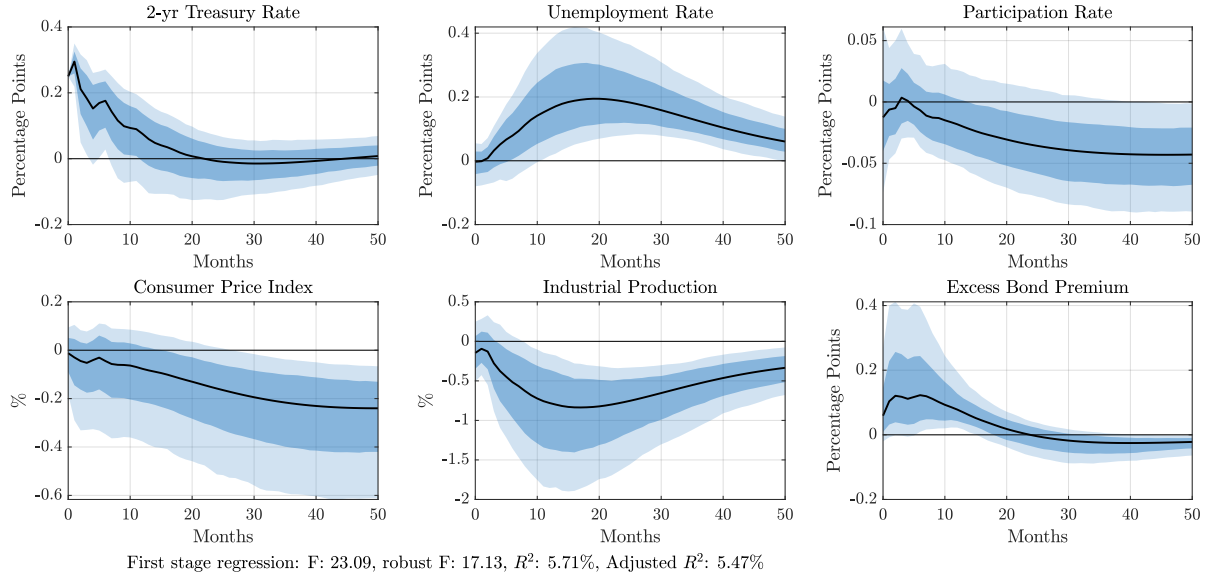
The impact effect of a monetary policy shock on the 2-year Treasury yield is normalized to a 25bp tightening. After impact, the 2-year Treasury yield increases

¹⁰Note that $z_t \neq \varepsilon_t^{mp}$ in general, because not all the news about monetary policy each month is released in FOMC announcements and Fed Chair speeches. For example, speeches by other FOMC members and minutes of FOMC meetings also contain important information about monetary policy.

¹¹Swanson and Jayawickrema (2023) use a 30-minute window around FOMC announcements, a 2-hour window around Fed Chair speeches other than Congressional testimony, and a 3.5-hour window around the Chair’s Congressional testimony, and shorten those windows as necessary to avoid overlapping with any other significant macroeconomic data releases.

¹²One can obtain the same point estimates for s_1 by regressing the reduced-form residuals u_t from (3) on u_t^{2y} using z_t as the instrument. Stock and Watson (2018) recommend using specification (7) instead to avoid a generated regressor and correctly estimate the standard errors. Note also that the sample for the two-stage least squares regression (7) used to estimate s_1 does not have to be the same as for the reduced-form VAR in (3) used to estimate α and $B(L)$. Our high-frequency monetary policy surprise data are available only from 1988:1 to 2019:12, while we can estimate the reduced-form VAR coefficients α and $B(L)$ over the longer sample 1976:1–2019:12.

FIGURE 5. Response of Aggregate Variables to a Monetary Policy Shock

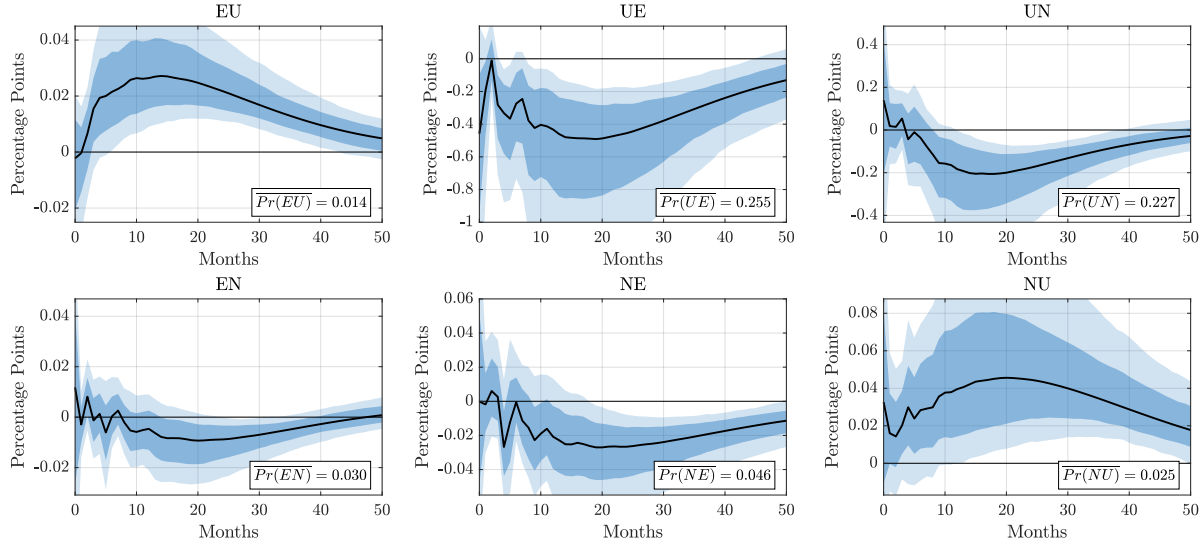


Note: Estimated impulse responses to a 25bp monetary policy tightening shock in the baseline VAR. Solid black lines report impulse response functions, while light- and dark-blue-shaded regions report bootstrapped 68% and 90% standard error bands. See text for details.

slightly and then gradually returns to steady state over the next 2.5 years. The Gilchrist and Zakrajšek (2012) excess bond premium, in the bottom right panel, increases by 5bp on impact and rises for several months before gradually returning to steady state. The other four variables—unemployment, labor force participation, industrial production, and the CPI—respond more sluggishly, with essentially no effect on impact. After a few months, industrial production begins to decline and the unemployment rate starts to rise, followed by a decline in labor force participation a few months later and, last of all, a decrease in the CPI. The peak effect is about 0.2 percentage points for the unemployment rate, almost -1 percent for industrial production, -0.05 percentage points for the labor force participation rate, and -0.2 percent for the CPI. These responses are similar to those from monetary policy VARs estimated by other authors, such as Bauer and Swanson (2023b), and are consistent with the aggregate economy weakening moderately and inflation falling slightly after a monetary policy tightening.¹³

¹³Note that, if the participation rate is interpreted as a measure of labor supply, as in Erceg and Levin (2014), then the decline of the participation rate in Figure 5 might be interpreted as evidence of a procyclical labor supply response to monetary policy. We will show below that labor market flows associated with a labor supply response are consistent with a *countercyclical* labor supply response to monetary policy. We also show below that procyclical participation and countercyclical labor supply flows are not inconsistent, but rather that the response of participation to monetary surprises should not be taken as a measure of labor supply at high frequencies.

FIGURE 6. Response of Labor Market Flows to a Monetary Policy Shock



Note: Estimated impulse responses to a 25bp monetary policy tightening shock, computed by appending the given labor market flow variable to the baseline VAR from Figure 5. Solid black lines report impulse response functions while light- and dark-blue-shaded regions report bootstrapped 68% and 90% standard error bands. See text for details.

We next extend this baseline monetary policy VAR to include labor market flows. Extending the VAR to include all six labor market flows (E to N, EU, NE, NU, UE, and UN) at once would introduce too many parameters into the VAR, resulting in poor estimates and overfitting, so we extend the baseline VAR with one labor market flow variable at a time (this is the same approach used by Gertler and Karadi (2015) to analyze financial market responses to monetary policy). The results for each labor market flow are reported in Figure 6. Each panel in Figure 6 corresponds to a separate seven-variable VAR—the six variables in the baseline VAR, above, plus the labor market flow variable listed at the top of the panel.¹⁴ Within each panel, we also report the average rate for that flow in the inset box—for example, 1.4 percent of employed workers move to unemployment each month, on average, while about 25.5 percent of unemployed individuals move to employment.

In response to a 25bp monetary policy tightening, the labor market flows in Figure 6 respond gradually, with either a small or statistically insignificant effect on impact and a peak effect after about one and a half years. The flow from employment to unemployment (EU) in the top left panel increases significantly after the monetary policy tightening, which is not surprising given the weakening aggregate economy. This increase may seem small at first glance—about 0.025 percentage points at its

¹⁴IRFs for the six baseline variables are not reported in Figure 6 in the interest of space, and because they are very similar to those from the baseline VAR in Figure 5.

peak—but it is sizeable relative to the steady-state flow of about 1.4 percent each month (as reported in the inset box).

What is more surprising in Figure 6 is the response of the flow from nonparticipation to unemployment (NU) in the bottom right panel. In response to the monetary policy tightening, the number of workers entering the labor force to look for a job (i.e., transitioning from N to U) *increases* significantly. Just as with the EU flow response, this increase of about 0.05 percentage points is quantitatively significant relative to the steady-state flow of about 2.5 percent each month. This novel finding immediately suggests a labor supply explanation—that is, that labor supply is increasing in response to the weaker economy—a hypothesis that we will investigate further below. The symmetric flow from unemployment to nonparticipation (UN) in the top right panel also falls in response to the monetary policy shock, again consistent with an increase in labor supply.

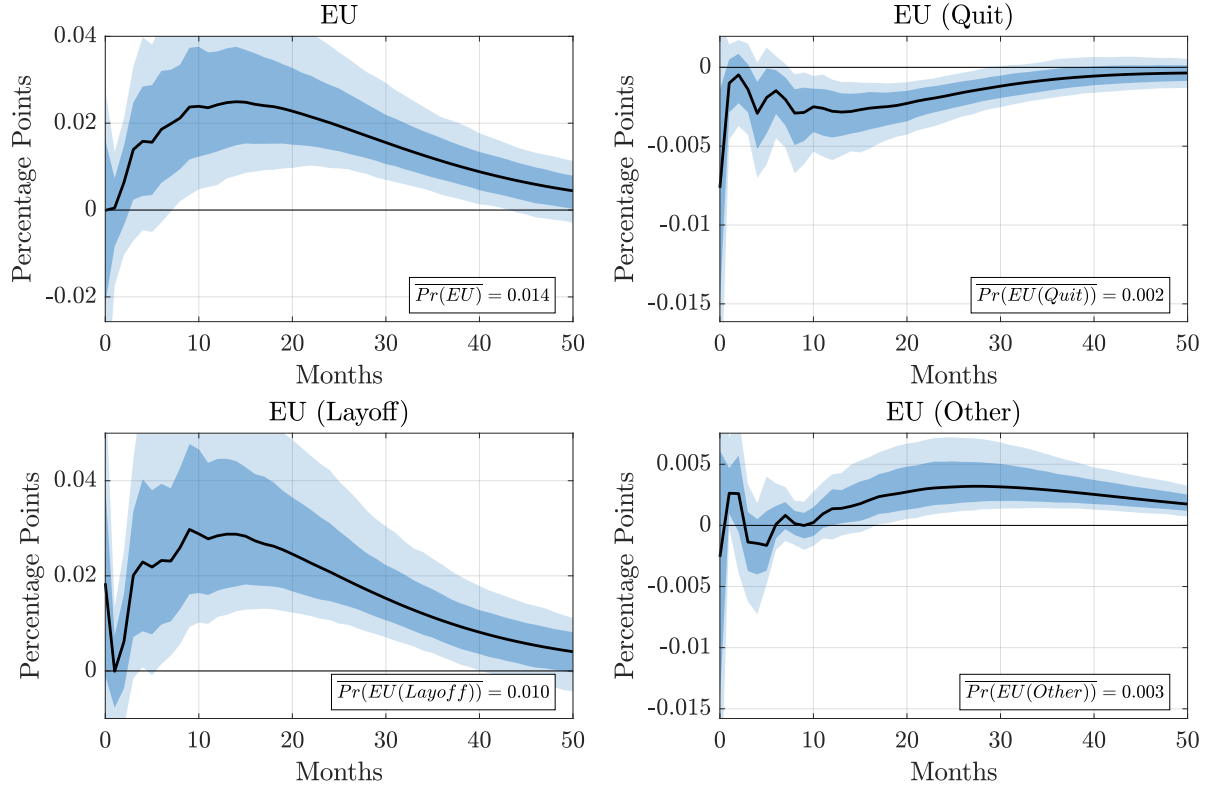
The response of the flow from unemployment to employment (UE) in the top middle panel of Figure 6 is also worth noting. We find that UE flows decrease significantly in response to the monetary policy tightening, consistent with the weakening economy and lower labor demand. However, previous authors, such as Faia et al. (2022), have often failed to find a significant response here. We speculate two reasons for the differences in our findings: First, our high-frequency measure of monetary policy surprises purges those surprises of correlation with previous economic and financial data releases. Bauer and Swanson (2023b) show that failing to orthogonalize the monetary policy surprises in this way results in impulse responses that are biased back towards zero. Second, our measure of monetary policy surprises includes speeches by the Fed Chair as well as FOMC announcements, which Bauer and Swanson (2023b) show gives us a much more powerful instrument than using FOMC announcements alone.¹⁵ As a result, our estimates of the impulse response functions in Figure 6 are likely to be less biased and more precise than those estimated elsewhere in the literature.

Finally, the flow from nonparticipation to employment (NE) in the bottom middle panel of Figure 6 responds similarly to the UE flow, but by a smaller amount. The flow from employment to nonparticipation (EN) in the bottom left panel declines modestly. We will show in the next section that a labor supply response is crucial for explaining why the EN rate declines in response to a contractionary shock, while the EU rate rises significantly.

Overall, the labor market flow responses in Figure 6 suggest that monetary policy has *both* a labor demand and a labor supply effect. The EU, UE, and NE flow responses are all consistent with a weakening economy and weaker labor demand. On the other hand, the NU and UN flows—and as we will show, the EN flows too—suggest an *increase* in labor supply. Intuitively, households that face a weakening economy and worse employment prospects may increase their labor supply in order to maintain their income and consumption.

¹⁵See Figures B.3 and B.4 of the Appendix and the discussion therein for support of our interpretation of the difference in estimates.

FIGURE 7. Decomposition of E-U Response

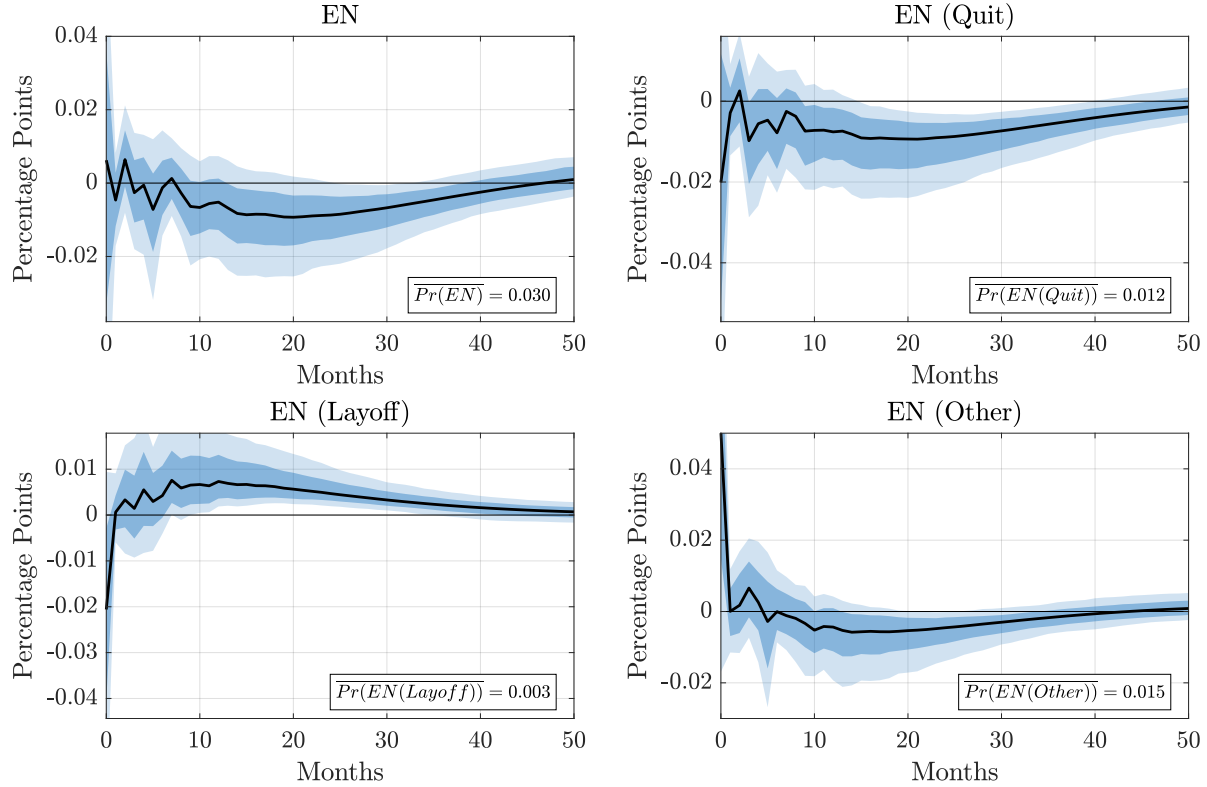


Note: Estimated impulse responses to a 25bp monetary policy tightening shock, computed by appending the given labor market flow variable to the baseline VAR from Figure 5. Solid black lines report impulse response functions while light- and dark-blue-shaded regions report bootstrapped 68% and 90% standard error bands. See text for details.

As a robustness check on these results, Appendix Figure B.1 repeats the analysis in Figure 6, but using labor market flow measures that hold the composition of the labor force constant in response to the shock, as in Elsby, Hobijn and Şahin (2015). The results in Figure B.1 are essentially identical to those in Figure 6, implying that changes in the composition of the labor force over the business cycle are not driving our results.

We also check that the increase in UN flows is not an artifact of an increasing share of workers in unemployment due to layoff, in Appendix Figure B.2. The IRF for the total UN flow is similar to the separate IRFs for workers in unemployment due to quits versus layoffs. Thus, our finding of diminished UN flows is not driven by cyclical changes in the shares of quits versus layoffs among workers in unemployment.

FIGURE 8. Decomposition of E-N Response

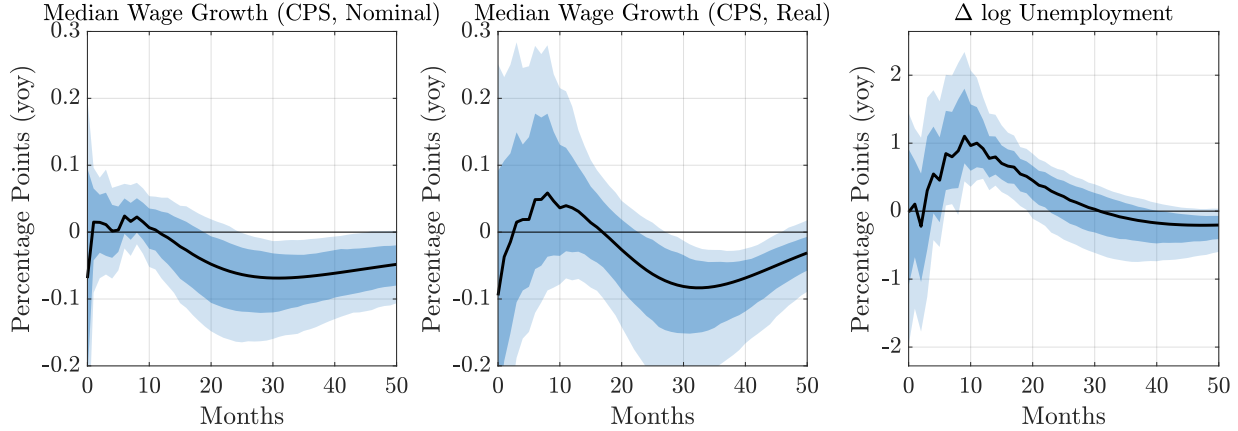


Note: Estimated impulse responses to a 25bp monetary policy tightening shock, computed by appending the given labor market flow variable to the baseline VAR from Figure 5. Solid black lines report impulse response functions while light- and dark-blue-shaded regions report bootstrapped 68% and 90% standard error bands. See text for details.

3.1. Quits and Layoffs after a Monetary Policy Surprise. We provide further evidence of the labor demand and labor supply effects of monetary policy by decomposing the flows from employment to unemployment (EU) and employment to nonparticipation (EN) into quits and layoffs. Once again, we find both a labor demand and a labor supply response: a surprise monetary policy tightening increases layoffs and reduces quits to non-employment. Thus, the overall impact of a contractionary monetary policy surprise on separations to non-employment reflects a decrease in labor demand that is muted by an increase in labor supply.

Figure 7 shows a decomposition of the IRF for flows from employment to unemployment (EU) in response to a 25bp monetary policy tightening. The small portion of EU flows associated to quits decrease in response to the contractionary monetary surprise, whereas the larger portion associated to layoffs increase. The remaining portion of EU flows which cannot be definitively associated to layoffs or quits slightly increases.

FIGURE 9. Response of Wages and Unemployment



Note: Annual (hourly) wage growth is calculated using employed individuals in the outgoing rotation groups of the CPS. We add the median value of nominal and real wage growth to the baseline VAR. For unemployment, we replace the level of unemployment in the baseline VAR with the annual log change for comparability with the wage growth measures.

Figure 8 shows the analogous decomposition of the IRF for flows from employment to nonparticipation (EN). We find that a monetary policy surprise generates a decrease in quits and an increase in layoffs, both statistically significant at the 90% level. Thus, the relatively moderate decline in the EN rate overall explained by the countervailing responses of quits and layoffs. The response of the remaining portion of EN flows that cannot be definitively categorized shows a reduction in response to the contractionary monetary policy surprise.¹⁶

The reduction in quits and increase in layoffs in response to a monetary policy surprise, shown in Figures 7 and 8, supports the notion of an economically meaningful distinction between quits and layoffs. The differential responses of quits and layoffs can be understood through an allocative role for wages, where wages are sufficiently sticky that they cannot be lowered enough to prevent a layoff in response to a contractionary monetary policy surprise, or raised enough to prevent a quit after an expansionary monetary policy surprise.

Given that this interpretation is reliant on wage stickiness, to develop a notion of the movement of wages relative to labor market quantities, Figure 9 plots within-individual year-over-year wage growth relative to year-over-year changes in the log unemployment rate. In nominal terms, year-over-year within-individual log wage growth does not decline until ten months into the monetary contraction, reaching

¹⁶While we do not categorize it as such, this is consistent with this also being driven by labor supply forces. For example, a tightening of monetary policy may lead to a delay in retirements.

a trough of around -0.08 percentage points at around 30 months after the monetary policy surprise. In real terms, within-individual year-over-year log wage growth reaches a trough of -0.1 percentage points after around 32 months, at which point it begins its recovery. The response of year-over-year log unemployment, however, is far more dramatic, immediately rising to a peak of one percentage point 10 months after the monetary policy shock.

Thus, the results of Figure 9 are consistent with a wage that adjusts relative modestly compared to labor market quantities. Given the increase in layoffs and decrease in quits in the IRFs for EN and EU flows (shown in Figures 7 and 8), we interpret our findings as evidence for a sticky wage that is allocative for quits and layoffs, consistent with Jäger et al. (2022) and Davis and Krolkowski (2022).

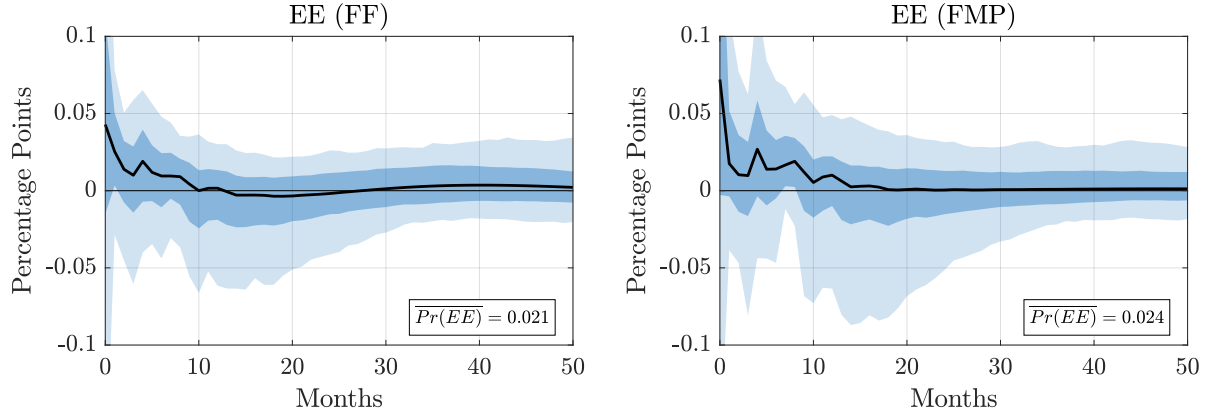
Aside: Job-to-Job Transitions. Having considered quits to non-employment, we now consider the role of quits that are due to job-to-job transitions. Beginning with Faberman and Justiniano (2015), an empirical literature has documented that a high unconditional correlation between quits and wage growth. While Faberman and Justiniano interpret quits to be job-to-job transitions, subsequent papers directly measure job-to-job transitions and document a robust unconditional correlation between job-to-job transitions with various measure of wage growth, e.g., Moscarini and Postel-Vinay (2016) and Karahan et al. (2017).

Thus, a recent literature has augmented the New Keynesian model with Bertrand wage competition over workers, à la Cahuc et al. (2006). Under the “offer-matching theory of inflation,” e.g., Birinci et al. (2022), Moscarini and Postel-Vinay (2022), and Faccini and Melosi (2023), competition between firms over workers bids up wages and increases marginal costs. The offer-matching theory implies the rate of job-to-job changes to be an important measure of labor market slack: a contractionary monetary policy shock should decrease inflation in part by reducing the rate of job-to-job transitions, and more importantly, the rate at which workers meet potential employers that allow them to bid up their wages at their current job. Thus, the theory implies that a contractionary monetary policy surprise should generate a robust decline in job-to-job transitions.

To assess the offer-matching theory of inflation, we estimate the IRF for the rate of job-to-job transitions in response to a contractionary monetary policy surprise. We consider two measures of job-to-job transitions: one due to Fallick and Fleischman (2004), and another due to Fujita et al. (2020). The estimated IRFs are plotted in Figure 10. Neither measure of job-to-job transitions shows any significant response to a contractionary monetary policy shock.

Taken at face value, the estimated IRFs appear inconsistent with the offer-matching theory of inflation. However, we speculate that the flat IRFs of job-to-job transitions might reflect a problem of measurement: neither the Fallick and Fleischman (2004) nor the Fujita et al. (2020) measures of job-to-job transitions condition on whether or not workers making job-to-job transitions are moving to better-paying jobs. Tjaden and Wellschmied (2014) document that a considerable portion of workers making job-to-job transitions move to lower-paying jobs, perhaps to avoid an involuntary layoff

FIGURE 10. Response of Job-to-job Transitions



Note: Estimated impulse responses to a 25bp monetary policy tightening shock, computed by appending the given labor market flow variable to the baseline VAR from Figure 5. Solid black lines report impulse response functions while light- and dark-blue-shaded regions report bootstrapped 68% and 90% standard error bands. The left panel uses the job-to-job transition rate of Fallick and Fleischman (2004) while the right panel uses that of Fujita et al. (2020). See text for details.

to unemployment. Gertler et al. (2020) document that the fraction of workers making job-to-job transitions associated with an improvement in wages is highly procyclical. It is possible that a series measuring job-to-job changes to higher-paying jobs might offer a more robust series by which to assess the offer-matching theory of inflation.¹⁷

3.2. Intensive Margins of Labor Supply after a Monetary Policy Surprise.

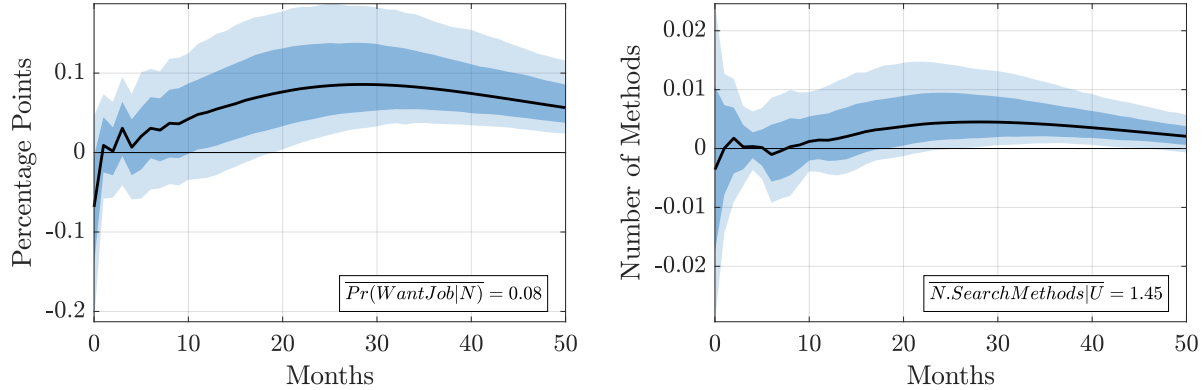
As we have shown, a contractionary monetary policy surprise spurs a reallocation within non-employment from nonparticipation to unemployment. Moreover, the resulting increase in layoffs to unemployment and decline in quits to nonparticipation further tilts the composition of non-employment towards unemployment and away from nonparticipation. This pushes up the “search rate” of non-employment, $U/(U+N)$, which we interpret as an increase in labor supply from non-employment.

Here, we examine the response of “internal margins” of labor supply to a monetary policy surprise. Such responses are not associated with a change in the labor market status of a worker, but reflect an increased desire to work and may influence the rate at which workers move to employment.

As in Section 2.3, we first look at the fraction of nonparticipants who report wanting a job despite not being engaged in active search. As discussed earlier, such workers find employment at a substantially higher rate than nonparticipants reporting

¹⁷Another feature of the job-to-job transitions data is that it is only available after the re-design of the CPS in 1994. However, we do not believe that this short sample is responsible for the estimated non-response of job-to-job transitions: if we restrict Figure 6 to the same shorter sample the estimated responses are largely unchanged, albeit with larger confidence intervals.

FIGURE 11. Response of Intensive Margins of Labor Supply



Note: Our measurement of the fraction of nonparticipants that want a job and the number of search methods used by unemployed individuals is described in Section 2.3. Estimated impulse responses to a 25bp monetary policy tightening shock, computed by appending the given variable to the baseline VAR from Figure 5. Solid black lines report impulse response functions while light- and dark-blue-shaded regions report bootstrapped 68% and 90% standard error bands. See text for details.

no desire to work.¹⁸ The first panel of Figure 11 shows the IRF for the fraction of nonparticipants who report a desire to work. There is a robust and persistent increase in the desire to work among workers in nonparticipation in response to the monetary policy surprise. Hence, the movement of workers from nonparticipation to unemployment in response to a monetary policy surprise may be considered part of a broader labor supply response within non-employment.

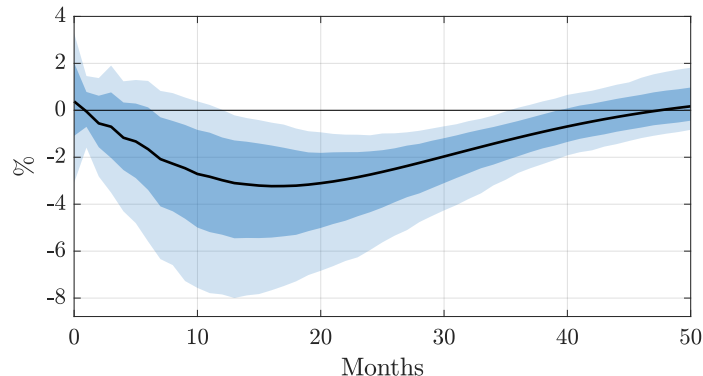
Next, we look at the number of job search methods used by workers in unemployment. As discussed in Section 2.3, this metric has been adopted elsewhere in the literature and has been shown to be highly correlated with time spent looking for a job, e.g., Osberg (1993), Shimer (2004), and Mukoyama et al. (2018). Moreover, unemployed workers who use two or more search methods are around 15% more likely to transition to employment than those that only use one search method. The second panel of Figure 11 shows the IRF for the number of search methods of unemployed workers. After a contractionary monetary policy surprise, the average number of search methods used by unemployed workers gradually increases, peaking at around 24 months.

These findings show that, even within distinct labor market states, workers exhibit behavioral responses to a contractionary monetary policy surprise consistent with an increase in labor supply.

3.3. Considering UE and NE flows. As established above, a contractionary monetary policy surprise increases unemployment via both demand and supply channels.

¹⁸Non-participants that report wanting a job are almost four times more likely to move to employment in the following month than non-participants who do not want a job.

FIGURE 12. Response of Vacancies



Note: We measure vacancies using the extended help-wanted index of Barnichon (2010).

The ensuing increase in unemployment is sustained in part through a reduction in the rate at which workers move from unemployment to employment, as shown in Figure 6. All else equal, any increase in unemployment should reduce the rate at which workers from non-employment find jobs.

However, a full understanding of the response of UE and NE rates to a monetary policy surprise requires an analysis of vacancy posting by firms. Figure 12 shows the IRF of vacancies v in response to a contractionary monetary policy surprise. Vacancies show a gradual decline, reaching a trough at around 15 months. To the extent that the process by which workers and vacancies match to create jobs can be understood through a matching function, a decline in vacancies will lead to a decline in the probability that a worker finds a job from unemployment. Thus, UE and NE rates fall.

Should we ascribe any of the decline in UE rates to labor supply factors? At a first glance, any increase in unemployment could increase market tightness $\theta = v/u$ and correspondingly decrease job finding probabilities and UE flow rates. However, to the extent that the value that a firm places on a job is unaffected by labor supply considerations and vacancy posting is subject to a free entry condition, supply-driven increases in unemployment should not induce changes in the UE rate. Under these assumptions, labor market tightness θ will be pinned down by the value of a new job to the firm and vacancy posting will increase to offset the changes in labor market tightness from supply-driven inflows into unemployment. Thus, our baseline assumption in the next section is that changes in NE and UE rates reflect labor demand factors rather than endogenous responses to shifts in labor supply.

4. DECOMPOSITIONS

The previous section documents that labor market flows respond to a contractionary monetary policy surprise in a manner consistent with a decline in labor demand and an increase in labor supply. Here, we analyze the extent to which increases

in aggregate labor market stocks such as unemployment, the employment-population ratio, and labor force participation are driven by changes in various underlying flows. We rely on equation (1), which expresses the evolution of aggregate labor market stocks as a function of labor market flows. Thus, we consider counterfactual paths for labor market stocks in which key flows do not respond to monetary policy shocks. In doing so, we are able to construct alternative paths of aggregate labor market stocks in which labor supply flows do not respond to monetary policy.

4.1. The Ins and Outs (and Everything Else) of Unemployment. Going back to Darby et al. (1986), an empirical literature has studied whether inflows from employment or outflows from unemployment are more important for explaining the total variation in unemployment over the business cycle. An influential paper by Shimer (2012) argues for the primacy of the outflow rate, arguing that the job-finding rate explains three-quarters of the total variation in unemployment. Although disagreements remain about the total contribution of outflows relative to inflows — for example, Elsby et al. (2009) provide evidence for a more prominent role for separations, and Fujita and Ramey (2009) argue that inflows explain up to half of the total unconditional variation in unemployment — the dominant quantitative DMP modelling paradigm has largely followed the conclusion of Shimer (2012) and abstracts entirely from cyclical separations, including Shimer (2005), Hall (2005), Hagedorn and Manovskii (2008), Hall and Milgrom (2008), Gertler and Trigari (2009), and Christiano et al. (2016).¹⁹

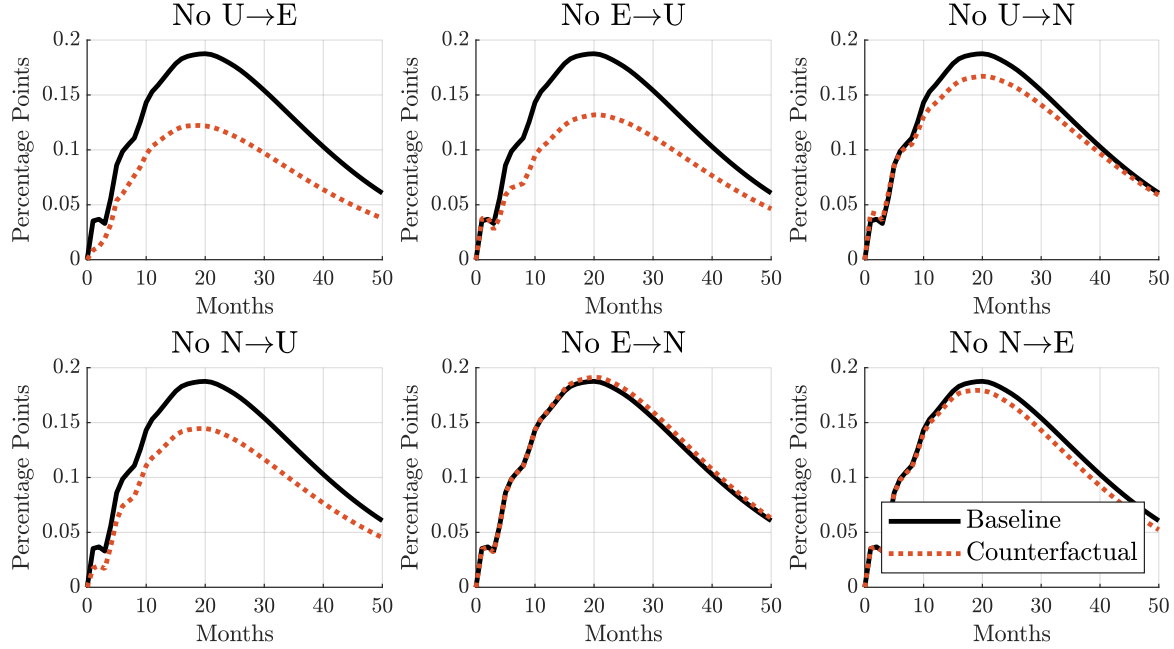
We now use the decomposition of the unemployment rate into labor market flows implied by equation (1) to study the contribution of each flow to unemployment in response to monetary policy shocks. Our motivation is twofold: First, analyses of unconditional variation in unemployment à la Shimer (2012) implicitly consider the impact of multiple shocks to unemployment. It is an open question whether the relative importance of job-finding and job-separation rates in response to monetary policy should be the same as the unconditional importance, given that some authors have used the latter to argue for the importance of shocks that directly interfere with the process by which workers and firms meet, including shocks to matching efficiency, e.g. Sala et al. (2012) and Furlanetto and Groshenny (2016).

Second, the assessment of the relative importance of job-finding versus separations in determining the unconditional dynamics of unemployment is sensitive to filtering procedures, as discussed by Fujita and Ramey (2009). Insofar as our specification follows best practices from the monetary SVAR literature, our results can be seen as consistent with the methodology of a well-established paradigm.

We calculate counterfactual IRFs where we assume a given flow remains at its average level, but we take the estimated IRFs for the other flows as given. We feed the IRFs into equation (1) for each horizon t , and we used the implied stocks $\{E_t, U_t, N_t\}$ to calculate the unemployment rate for each date t , $u_t = U_t/(U_t + E_t)$.

¹⁹Some important exceptions to this paradigm include Menzio and Shi (2011), Fujita and Ramey (2012), and Elsby and Michaels (2013).

FIGURE 13. The Ins and Outs of Unemployment



Note: The black solid line shows overall response of the unemployment rate to a contractionary monetary policy shock. The red dotted lines show the response if we hold individuals flow rates constant.

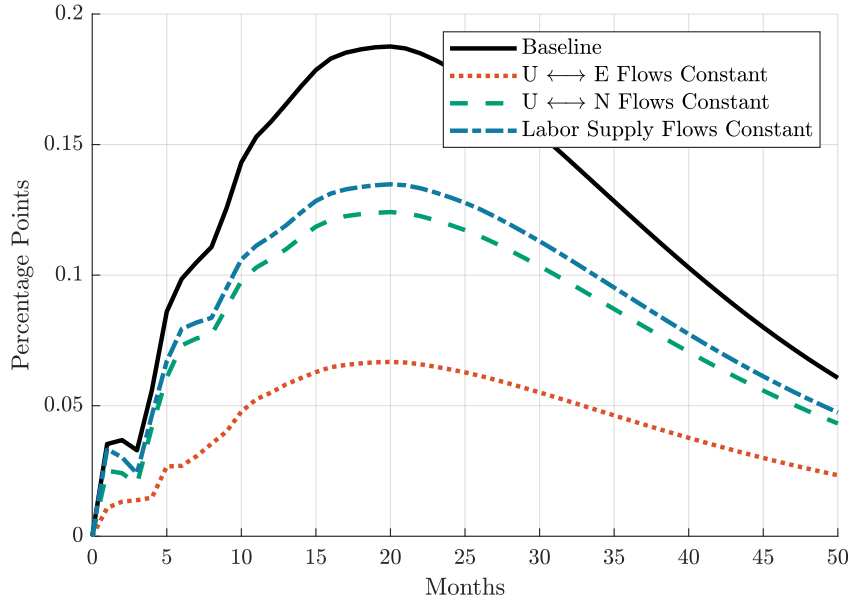
We perform the procedure for each of the given six flows across the three distinct labor market states.

The counterfactual impulse responses are plotted in Figure 13. The solid black lines show the IRFs for unemployment estimated from our baseline VAR. The dotted red lines show the counterfactual IRFs generated when we “turn off” the response of a given transition probability to the monetary policy surprise. The greater the distance between the counterfactual and baseline IRF, the more important is the transition probability in generating the total response of unemployment to the contractionary monetary policy shock. The subplots of Figure 13 show that the counterfactual IRFs holding the EU and UE responses constant reach roughly similar levels of peak unemployment: the IRF with constant UE flows reaches 65% of the baseline, whereas the IRF with constant EU flows reaches 70%.

Hence, our estimates imply that EU and UE responses to monetary policy shocks offer roughly equal contributions to the overall increase in unemployment from a monetary policy shock. These findings imply that New Keynesian models accounting for the behavior of labor market aggregates in response to monetary policy should offer some mechanism to account for the cyclical nature of involuntary separations.

Note, the figure shows that NU and then UN flows fall next in importance for explaining the total increase of unemployment in response to a monetary policy shock.

FIGURE 14. Unemployment Counterfactuals



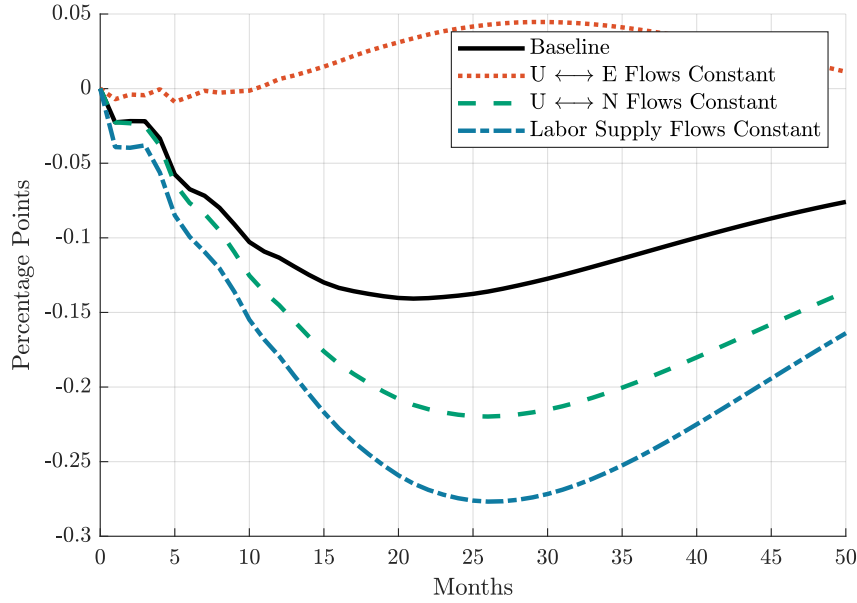
Note: “Labor Supply Flows Constant” shuts down the response of flows between U and N as well as the response of quits from employment to U or N.

Given the argument of the previous section — that the conditional responses of UE and EU can be largely understood to reflect demand considerations, whereas NU and UN flows reflect supply considerations — Figure 13 might thus be interpreted as evidence that labor supply is relatively inconsequential for understanding the labor market response to a monetary policy surprise. In the next section, we show otherwise.

4.2. The Labor Supply Channel of Monetary Policy. Recall, in Section 3, we document that the majority of the substantial increase in EU flows after a monetary policy surprise are due to layoffs, which we interpret as reflecting labor demand considerations. We also argue that, under a free entry condition for vacancy posting, the reduction in UE flows following a contractionary monetary policy surprise can be understood as reflecting considerations related to labor demand. On the other hand, we document a substantial increase in NU and decrease in UN flows, which we interpret as an increase in labor supply. We also show that a contractionary monetary policy shock lowers quits from employment to non-employment, which we also interpret as reflecting labor supply.

In this section, we study how unemployment, the employment-population ratio, the labor force participation rate, and the search rate from non-employment respond to monetary policy surprises through various labor demand and supply channels. In Figure 14 we begin by studying the unemployment rate, shutting down flows between E and U ($E \longleftrightarrow U$); flows between U and N ($U \longleftrightarrow N$); and the full labor

FIGURE 15. Employment Counterfactuals



Note: “Labor Supply Flows Constant” shuts down the response of flows between U and N as well as the response of quits from employment to U or N.

supply response, which we identify as flows between U and N plus quits to non-employment.²⁰ Given the discussion of the previous section, it should come as no surprise that the $U \leftrightarrow E$ to a monetary policy surprise accounts for the majority of the increase in unemployment. The removal of $U \leftrightarrow N$ flows lowers the response of unemployment by one third, consistent with the findings of Elsby et al. (2015). The additional removal of quits (“Labor Supply Flows Constant”) hardly changes the peak unemployment response further.

Figure 15 shows the same decompositions, but for the response of the employment-population ratio to a contractionary monetary policy surprise. Here, we see an important role for $U \leftrightarrow N$ flows, as well as a broader labor supply response: $U \leftrightarrow N$ flows + quits to non-employment. The removal of $U \leftrightarrow N$ flows to leads to a peak fall in the employment-population ratio that is almost 60% larger than in the baseline.

²⁰Elsby et al. (2015) study how unemployment and labor force participation would evolve across the 1980s and 2008 recessions by similarly shutting down $E \leftrightarrow U$ and $U \leftrightarrow N$ flows. We follow their study as close as possible for ease of comparison. We analyze the labor supply response, $U \leftrightarrow N$ + quits, separately given the important role of quits to non-employment documented in Section 3. However, given the dominant role of layoffs in determining EU flows (and minor role in determining EN flows), the counterfactuals stocks removing $E \leftrightarrow U$ shut down much of the labor demand response (but exclude the labor demand effect on NE rates).

Why does removing $U \longleftrightarrow N$ flows have such a substantial impact on employment? Recall, even though workers in nonparticipation and unemployment both see a reduction in the rate at which they go to employment, UE rates are substantially higher than NE rates. Given that shutting down the response of $U \longleftrightarrow N$ flows implies that more individuals remain in nonparticipation, this has a large effect on the overall rate at which workers move from non-employment to employment. To our knowledge, ours is the first study to document the importance of $U \longleftrightarrow N$ flows to either the unconditional or conditional cyclical behavior of employment.

We then show that to quantitatively understand the full importance of labor supply responses, it is also important to take into account the response of quits. When we remove $U \longleftrightarrow N$ flows + quits the employment-population ratio falls by roughly an additional 40%. Hence, absent the full labor supply response to a contractionary monetary policy surprise, the reduction in the employment-population ratio would nearly double.²¹

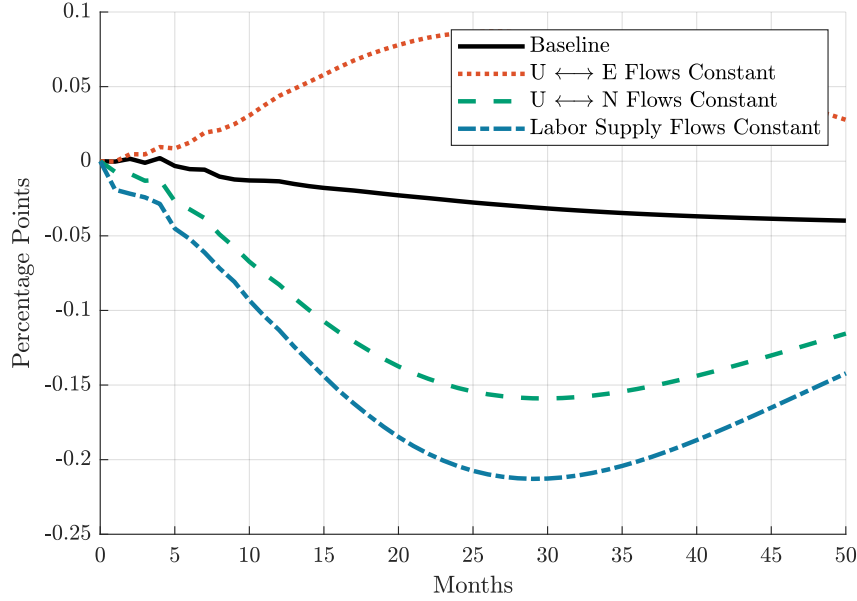
What happens to employment if we allow labor supply flows to respond, but we hold $U \longleftrightarrow E$ flows constant? Recall, the response of $U \longleftrightarrow E$ flows to a contractionary monetary policy surprise are characterized by increased layoffs from E to U and a decline in the UE rate. We see that the employment-population ratio actually rises once we shut down the response of $U \longleftrightarrow E$ flows, implying that the labor supply response — through a shift in flows between N and U and a decline in quits to non-employment — is large enough to outweigh the important effect of the decline in the NE transition rate.

The strongly countercyclical increase in labor supply in response to a monetary policy surprise might seem to odd given the procyclical response of the labor participation ratio that we estimate from our baseline IRFs. To understand how such a strong labor supply response can be consistent with a decline in the labor force participation ratio, we study a similar decomposition for the labor force participation ratio in Figure 16. Shutting down $U \longleftrightarrow N$ flows alone or labor supply flows entirely generates a substantially larger decline in the labor force participation rate than under the baseline. The shift in the composition of workers from nonparticipation to unemployment increases the participation rate directly, but also indirectly, given that the unemployed are much more likely than nonparticipants to move to employment, and employed individuals are much less likely than the unemployed to exit the labor force.

Shutting down $U \longleftrightarrow E$ flows, however, counterfactually increases labor force participation, for roughly the same reasons that the employment population ratio increases under the same counterfactual: the labor supply driven shift from N to U

²¹Note here we are not including the decline in “other” separations to nonparticipation in the labor supply response. This is a conservative assumption, given that such separations, which include retirements as well as individuals that are “tired of working”, have similar cyclical properties to quits to nonparticipation and are of a similar magnitude.

FIGURE 16. Participation Counterfactuals



Note: “Labor Supply Flows Constant” shuts down the response of flows between U and N as well as the response of quits from employment to U or N.

and the decline in quits to non-employment pushes up the participation rate, and dominates the decline in participation that comes from a fall in the NE rate.²²

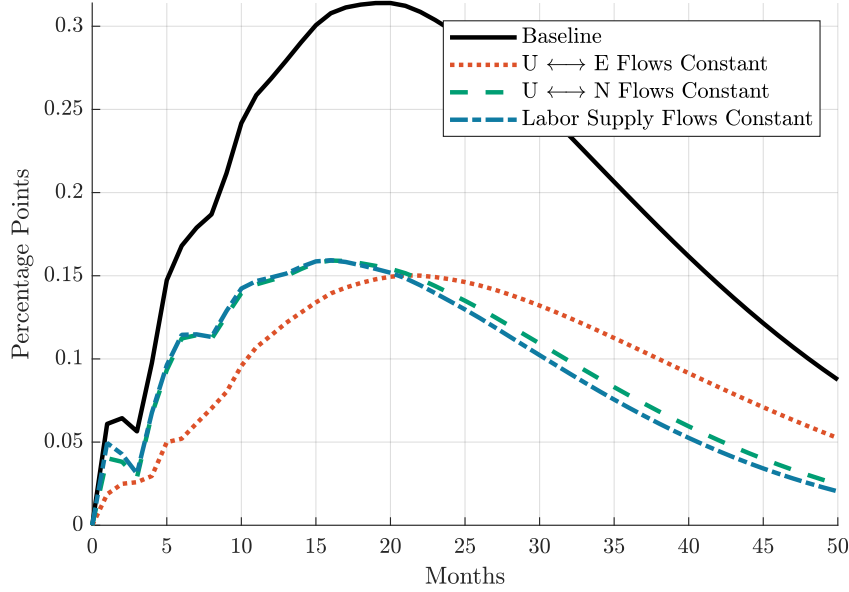
While labor force participation is often taken as a measure of labor supply, the previous discussion has shown that it is inadequate for studying labor supply responses at cyclical frequencies. Our discussion instead suggests the search rate from non-employment, $U/(N + U)$, is a more consistent measure of labor supply as it directly measures the desire to work of the non-employed, in contrast to labor force participation. The results in Figure 17 show that the rise in the search rate following a contractionary monetary policy shock is roughly equally driven by labor supply and labor demand forces.

5. HETEROGENEITY IN LABOR RESPONSES TO MONETARY POLICY: A FIRST LOOK

Our analysis thus far has focused on responses of aggregate labor stocks and flows to monetary policy surprises. Of course, individuals differ not only in their exposure to labor market risk, but also in their ability to insure against it; thus, one might expect labor responses to vary across groups of workers. Here, we take a first step in

²²Here, the counterfactual impulse responses of nonparticipation are similar to those constructed by Elsby et al. (2015); and our discussion of the opposing roles of cyclical $U \leftrightarrow E$ and $N \leftrightarrow E$ flows is similar to Elsby et al. (2019) and Hobijn and Şahin (2021).

FIGURE 17. Search Rate Counterfactuals



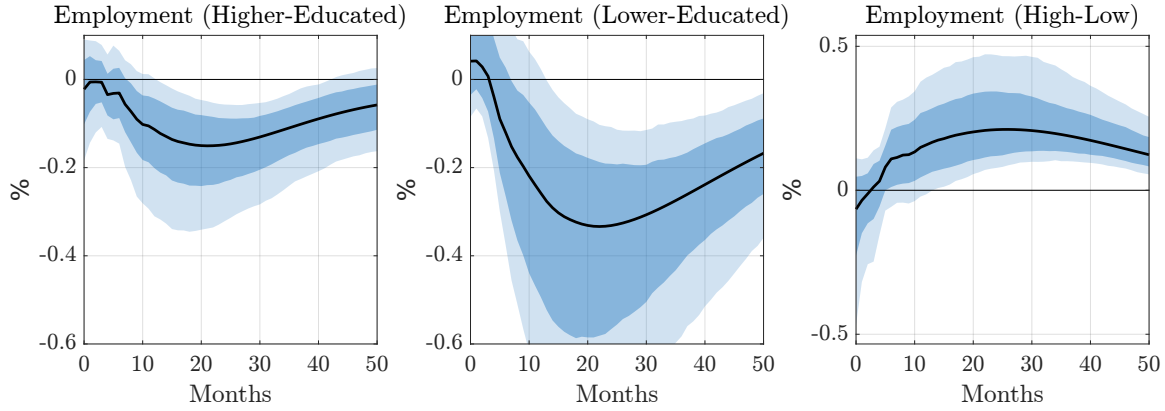
Note: The search rate is defined as the share of the unemployed in total non-employment. “Labor Supply Flows Constant” shuts down the response of flows between U and N as well as the response of quits from employment to U or N.

documenting economically and statistically significant demand and supply responses to monetary policy shocks across groups of workers. We restrict our analysis to lower- versus higher-educated workers: such workers differ not only in their exposure to monetary policy shocks through labor market risk, but also in their ability to insure against labor market risk through accumulated savings.

We first show that employment of lower-educated workers is more responsive to monetary policy shocks. Then, we establish that the greater sensitivity of lower-educated employment exists in spite of a larger countercyclical supply response among these workers. To the extent that lower-educated workers have fewer means by which to self-insure or consumption-smooth, our estimates indicate that lower-educated workers instead vary labor supply to respond to aggregate shocks.²³ Thus, we establish that the aggregate employment response to monetary policy depends on the composition of the labor force not only through differences in exposure to monetary policy-induced changes in labor demand, but also from cross-sectional differences in willingness to substitute away from leisure.

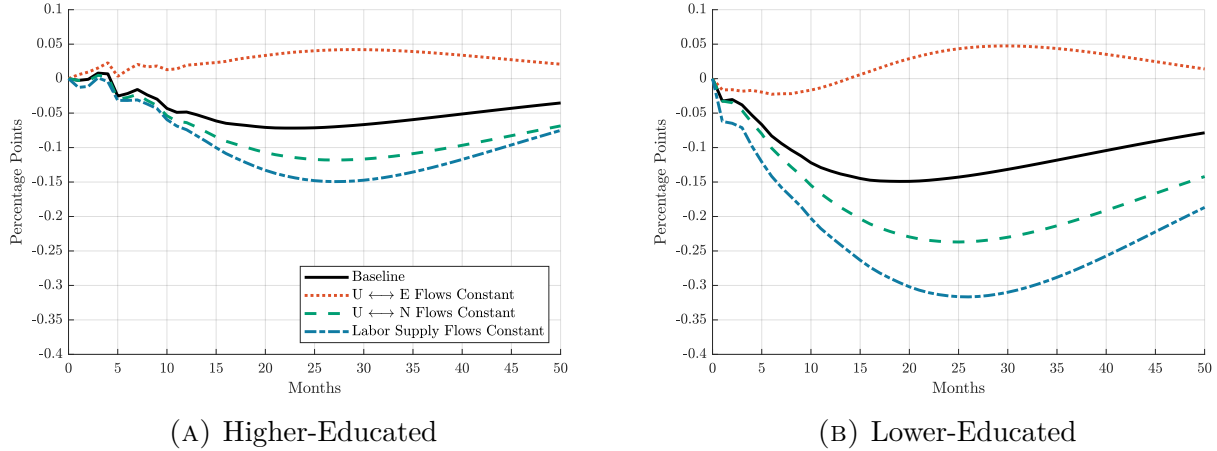
²³We classify an individual as higher-educated if they have attended at least some college, whereas a worker is designated to be lower-educated if their maximum educational attainment is a high school diploma.

FIGURE 18. Employment Response by Education



Note: We plot the response of log employment, or the difference in log employment across the two groups.

FIGURE 19. Employment Counterfactuals by Education



Note: “Labor Supply Flows Constant” shuts down the response of flows between U and N as well as the response of quits from employment to U or N.

Figure 18 shows the impulse responses of the employment population ratio to a 25bp contractionary monetary surprise for both groups, as well as the impulse response of the differences. Employment of higher-educated workers responds modestly to the contraction, reaching a maximum reduction of around -0.15 percent at 20 months. In comparison, the employment reduction for lower-educated workers is far more dramatic, dropping around -0.30 percent and remaining below zero even fifty months after the shock. As shown in the right-most panel, the larger employment response of lower-educated workers is statistically significant.

Figures B.5 and B.6 of Appendix B show the response of flows across labor market states for lower and higher-educated workers. These responses are broadly similar as those reported in Figure 6 for the aggregate, but with several noteworthy differences: First, the increase in EU rates to a monetary contraction is substantially larger for lower- than higher-educated workers, with peak increases of around 0.04 and 0.02 percentage points, respectively. Second, we find that the decline in EN flows is concentrated among lower-educated workers: for higher-educated workers there is no discernible drop. Finally, higher-educated workers show virtually no reduction in NE flows after a monetary contraction.

In Figure 19, we repeat the analysis of Section 4.2 to assess the importance of various flows in shaping the separate responses of employment to a monetary policy shock for lower- and higher-educated workers. Under the baseline IRF, employment drops by around 0.15 percentage points for lower-educated workers versus around 0.07 percentage points for higher-educated workers. Holding all labor supply flows fixed, the reduction in employment increases is greater than 0.30 percentage points for lower-educated workers, against 0.15 for higher-educated workers. Compared to higher-educated workers, the percentage point contribution of labor supply flows in moderating the overall employment response to a monetary policy surprise is larger, and with a proportionally larger role for quits.

We see two important takeaways from these estimates: First, monetary policy shocks do not hit all workers equally. Lower-educated workers see greater employment declines from a monetary policy contraction, in part from a more responsive layoff margin. Second, labor supply responses show important differences across groups. Lower-educated workers appear to adjust their labor supply more aggressively to offset the negative employment impact of a monetary policy shock. Given that such workers are likely to be more constrained in their ability to consumption smooth by drawing from liquid assets, this result implies that labor supply heterogeneity may be an important channel through which the cross-sectional distribution of households mediates the overall effects of monetary policy.

6. A SIMPLE MODEL OF COUNTERCYCLICAL LABOR SUPPLY TO MONETARY POLICY SURPRISES

Our empirical analysis shows a countercyclical labor supply response to a monetary policy surprise: a contractionary monetary policy shock increases job-seeking behavior and diminishes the rate at which workers quit to non-participation. Here, we use a simple partial equilibrium model to establish the economic plausibility of our empirical findings. In the model, we consider a monetary policy contraction as a reduction in the job-finding rate and an increase in the marginal utility of consumption and then compute comparative statics around a stationary equilibrium.

As we demonstrate, the model includes both a substitution effect on participation—whereby the reduction in the job-finding rate deters job search, inducing workers to move from unemployment to non-participation—and also an income effect—where the increase in the marginal utility of consumption reduces the consumption-equivalent

value of leisure, so that workers move from non-participation to unemployment. For our simple model to be consistent with the data, the income effect must dominate. We also show that the model generates a reduction in quits in response to both lower job-finding rates and a higher marginal utility of consumption. Hence, we speculate that the incorporation of frictional labor markets, a participation decision, and sufficiently strong income effects can allow the New Keynesian framework to account for our new empirical findings.²⁴

6.1. Setting. Time is continuous, and there is an infinite horizon. There is a unit measure of households. Each household consists of a continuum of workers who insure each other against labor market risk. Workers receive utility from consumption and leisure, have time separable preferences, and discount the future at a constant rate r . The model is set in partial equilibrium: the worker takes the wage w and job-finding rate λ as given. A worker may be employed or non-employed. The worker sacrifices some leisure to search, and enjoys no leisure at all when employed. Workers are heterogeneous in the fixed amount of leisure b that they receive while not working. Workers draw a new flow value of leisure b' at rate χ from a distribution F with fixed support $[\underline{b}, \bar{b}]$.

Define $V_0(b)$ as the value of non-employment in consumption equivalent units. The worker chooses whether or not to engage in active search, i.e., selects $s \in \{0, 1\}$. If she chooses to engage in active search, so that $s = 1$, she incurs a disutility cost from leisure ψ , but finds jobs at a higher rate, equal to λ if $s = 1$ and $(1 - \alpha) \cdot \lambda$ if $s = 0$, where $\alpha \in (0, 1)$. Thus, the annuity value of unemployment in consumption-equivalent units can thus be expressed as

$$rV_0(b) = \max_{s \in \{0, 1\}} \left\{ \frac{b - \psi \cdot \mathbb{I}\{s = 1\}}{\mu} \right. \quad (8)$$

$$+ \left(\alpha \cdot s + (1 - \alpha) \right) \cdot \lambda \cdot [\max\{V_1(b), V_0(b)\} - V_0(b)] \\ \left. + \chi \cdot \left[\int_{\underline{b}}^{\bar{b}} V_0(b') dF(b') - V_0(b) \right] \right\} \quad (9)$$

where $V_1(b)$ is the consumption-equivalent value of employment of a worker with a flow value of leisure b .

Note, the flow value of leisure is scaled by the marginal utility of consumption, μ , where the marginal utility of consumption is equalized within the representative family. Thus, when the consumption drops (so that the marginal utility of consumption increases), the worker places less value on leisure. Although workers not searching from non-employment encounter jobs at a rate $(1 - \alpha) \cdot \lambda$, workers with a high enough value of leisure b/μ might be unwilling to accept a job. Hence, workers receiving job offers compare the value of work against the continued value of non-employment, as seen in the max operator in the second line of equation (9).

²⁴The modeling ingredients highlighted here have already been introduced in the pioneering work of Krusell et al. (2017, 2020) within the RBC framework and are the subject of further study by Cairó et al. (2022).

Next, consider the annuity value of employment in consumption equivalent units:

$$rV_1(b) = w + \delta \cdot [V_0(b) - V_1(b)] + \chi \left[\int_{\underline{b}}^{\bar{b}} \max\{V_0(b'), V_1(b')\} dF(b') - V_1(b) \right] \quad (10)$$

The only decision of the employed worker is whether to quit her job when she draws a new flow value of leisure, b' .

6.2. Searching, accepting a job, and quitting. Non-employed workers make two decisions: whether or not to search, and whether or not to accept a job. Employed workers make a single decision: whether or not to quit to non-employment.

In the Appendix, we show that the value of employment and non-employment is strictly increasing in the flow value of leisure b . We also show that the surplus from employment, $V_1(b) - V_0(b)$, is decreasing in b . We use these results to establish the existence of unique thresholds S and Q such that $\underline{b} < S < Q < \bar{b}$. Non-employed workers strictly prefer to search for a job when $b < S$, are indifferent between searching and not searching when $b = S$, and strictly prefer to not search when $b > S$. Non-employed workers strictly prefer accepting a job when $b < Q$, are indifferent between accepting a job and not accepting a job when $b = Q$, and strictly prefer to not accept a job when $b > Q$. Finally, employed workers are indifferent between remaining employed and quitting a job when $b = Q$, strictly preferring to remain employed when $b < Q$ and strictly preferring to quit to non-employment when $b > Q$.

We establish several useful results, beginning with Corollary 1:

Corollary 1 (S threshold). *Define $V_0^s(b)$ as the value of a non-employed worker who optimally engages in active search. Define $V_0^{ns}(b)$ as the value of a non-employed worker who optimally does not engage in active search, but accepts job offers from non-employment. Then, the threshold S such that $V_0^s(S) = V_0^{ns}(S)$ satisfies*

$$\frac{\psi}{\mu} = \alpha \cdot \lambda \cdot (V_1(S) - V_0(S)) \quad (11)$$

Proof. See Appendix C. □

Equation (11) defines the flow value of leisure S for which a non-employed worker is indifferent between not actively searching and actively searching. The left side of the equation expresses leisure cost of active search ψ in consumption units. The right side of the equation expresses the benefit of search: the non-employed worker finds jobs at rate λ when engaged in active search and at rate $(1 - \alpha) \cdot \lambda$ when not engaged in active search. Thus, $\alpha \cdot \lambda \cdot (V_1(S) - V_0(S))$ reflects the capital gains associated with the higher rate of job offers for a worker indifferent between actively searching and not actively searching.

We also establish Corollary 2:

Corollary 2 (Q threshold). *Define Q as the threshold flow value of leisure at which a non-employed worker is indifferent between accepting a job offer or remaining non-employed; or equivalently, the threshold value of leisure at which an employed worker*

is indifferent between remaining employed or quitting to non-employment. Then, the threshold Q satisfies

$$\frac{Q}{\mu} = w + \chi \int_b^Q (V_1(b') - V_0(b')) dF(b') \quad (12)$$

Proof. See Appendix C. \square

Note, the quitting/accepting threshold Q in consumption equivalent units is higher than the wage due to an option value from employment. The option value reflects that a worker may be hit by a preference shock that shifts her value of leisure below Q , in which case she will prefer employment.

6.3. Comparative statics. We study a contractionary monetary policy shock within our simple model by studying the comparative statics of the stationary model around a steady state where $\chi = 0$. We consider two sources of variation: a change in the aggregate job-finding rate, λ , and in the marginal utility of consumption, μ .²⁵

Proposition 1 (Substitution and income effects). *Consider a decrease in the aggregate component of the job-finding rate λ and an increase in the marginal utility of consumption μ . A decrease in the job-finding rate decreases the search threshold S , and thus induces less workers in non-employment to search; whereas an increase in the marginal utility of consumption does the opposite.*

Proof. See Appendix C. \square

To see the logic of the proof, see from the Appendix that, if $\chi = 0$, equation (11) can be written more simply as

$$\frac{\psi}{\mu} = \alpha \cdot \lambda \left(\frac{w - \frac{S-\psi}{\mu}}{r + \delta + \lambda} \right) \quad (13)$$

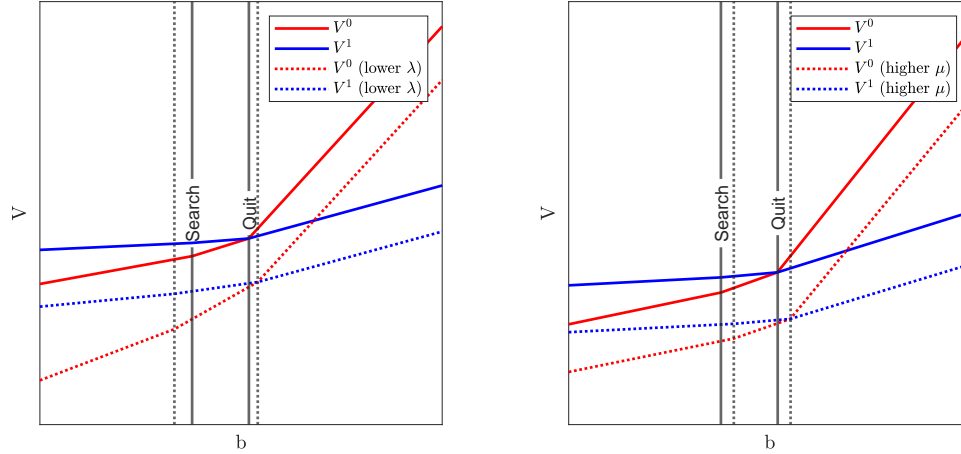
where the term in parentheses on the right side of equation (13) reflects the steady state surplus when $\chi = 0$. Thus, the left side of the equation reflects the cost of search, whereas the right side reflects the benefit. As shown in Figure 20, the reduction in λ decreases the rate at which workers find jobs, and thus the relative cost of search increases. This represents a pure substitution effect, and so S will thereby decrease and fewer workers will search.

Conversely, suppose that the marginal utility of consumption μ increases. In this case, not only does the consumption equivalent cost of search ψ/μ decrease, but the flow value of leisure $(S - \psi)/\mu$ declines, increasing the flow surplus of employment.²⁶ This represents an income effect, pushing S up so that a larger mass of non-employed

²⁵We could also consider the response of worker labor supply to changes in wages; however, as we show in Figure 9, the response of wages to a monetary policy shock is an order of magnitude smaller than that of labor market aggregates such as unemployment.

²⁶Note, such an income effect can be understood through Chodorow-Reich and Karabarbounis's (2016) notion of the "opportunity cost of leisure," which they estimate to be unconditionally procyclical. Our evidence suggests that the opportunity cost of leisure should be similarly procyclical in response to monetary policy shocks.

FIGURE 20. The Substitution and Income Effects of a Monetary Policy Shock



Note: In the left panel, a decrease in the aggregate component of job-finding rate λ increases S and thus decreases the fraction of workers in non-employment engaged in active search. In the right panel, an increase in the marginal utility of consumption μ decreases S and thus increases the fraction of workers in non-employment engaged in active search.

workers will be engaged in search, as shown in the right panel of Figure 20. In contrast, shocks to μ and λ move the quit threshold weakly in the same direction, as discussed in the Appendix.²⁷

Given a contractionary monetary policy shock that decreases the job-finding rate λ and increases the marginal utility of consumption μ , the substitution effect will drive the fraction of workers searching from non-employment down; whereas the income effect will drive the fraction of workers searching from non-employment up. Under our estimates of a countercyclical search rate from non-employment $U/(N+U)$ with respect to monetary policy surprises—as well as conditionally countercyclical NU flows and conditionally procyclical UN flows—our simple model suggests that the income effect should not only be present, but also sufficiently strong to offset the counteracting substitution effect.

The need for a strong income effect contrasts with the prescriptions of much of the New Keynesian literature featuring a neoclassical labor market clearing condition. In such models, income effects on labor supply are often suppressed by the introduction of wage stickiness. We show that in a search framework not only must such income effects be an important ingredient in explaining the response of labor market flows to a

²⁷If $\chi = 0$, the quit threshold is unaffected by changes in λ . In Figure 20 we set $\chi > 0$ and a decline in λ leads to a fall in Q .

monetary policy shock but that they are also operative even in our simple environment where wages are fixed.

7. CONCLUSION

This paper offers new empirical evidence of a sizeable labor supply response to monetary policy. Using high-frequency identified monetary policy shocks from FOMC announcements and Fed Chair speeches, we show that a contractionary monetary policy shock generates quantitatively important increases in labor supply by decreasing the rate at which workers quit jobs to non-employment and stimulating job-seeking behavior among the non-employed. Thus, the decline in labor demand from a monetary policy tightening is partially offset by an increase in labor supply. We show that if the response of supply-driven labor market flows is held fixed, the overall procyclical response of employment to monetary policy is almost twice as large.

An empirical contribution of our paper is to highlight the large and cyclical role of quits to non-participation. Previous research has shown that the vast majority of separations from employment to unemployment are due to layoffs rather than quits. We have shown that the opposite is true for separations from employment to nonparticipation. Our flow-based accounting framework reveals that, in response to a contractionary monetary policy shock, the decline in quits to non-participation is roughly as important as the increase in job-seeking behavior among the non-employed in dampening the overall decline in employment.

Given the importance of supply-driven flows revealed by our estimates, models intended to generate a realistic employment response to monetary policy may require a greater role for labor supply than currently considered in the New Keynesian literature. This may be especially true for models with an explicit role for heterogeneity à la Kaplan, Moll and Violante (2018). In a partial equilibrium setting, we have shown that a model with frictional labor markets, an active participation decision, and sufficiently strong income effects is likely to be consistent with our empirical findings. We believe that incorporating such features into a fully-fledged New Keynesian model is an important topic for future research.

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APPENDIX A. ADDITIONAL CPS MEASUREMENT DETAILS

A.1. Quits versus Layoffs. In order to understand the underlying drivers of flows from employment to non-employment, we decompose EU and EN flows into three components: quits, layoffs and other separations. We interpret quits as reflecting labor supply considerations and layoffs as being driven by labor demand.

The decomposition of EU flows is the more straightforward. Unemployed individuals in the CPS are asked their reason for unemployment. We label an EU transition as a quit if the reason for unemployment is “job leaver” and as a layoff if the reason for unemployment is “job loser/on layoff”, “other job loser” or “temporary job ended”.²⁸ The remaining EU transitions, we label as other separations.²⁹

The decomposition of EN flows is slightly more involved. A subset of individuals that are out of the labor force are asked the reason that they left their last job. However, the sample of such individuals has changed over time. Since 1994, this question is asked to individuals in the outgoing rotation group that are: (1) not in the labor force, (2) neither retired nor disabled and (3) who report having worked in the past 12 months. Prior to 1994 this question was asked to all individuals not in the labor force who reported having worked in the past five years. The possible answers to the question also changed slightly beginning in 1994.

To create a consistent series, we restrict our attention to individuals who report having worked in the past 12 months.³⁰ We label an EN transition as a quit if the reason for leaving the job is “personal, family or school” or “unsatisfactory work arrangements”.³¹ We label an EN transition as a layoff if the reason for leaving the job is “slack work or business conditions”. We label all remaining EN transitions as other separations.³² After 1994 we assume that individuals who make an EN transition and either report being retired or disabled would have given this as their reason for leaving their job had they been asked the question. Consequently, such transitions are defined as neither quits nor layoffs. Finally, as our sample is only ever a fraction of all EN transitions, in all periods we calculate the share of EN transitions in each classification and then multiply this by the overall EN transition rate to complete our

²⁸Ideally we would not label the end of a temporary job as a layoff. However, between 1989 and 1993 the CPS did not include “temporary job ended” as an option in the survey. It appears that during this period such transitions were classified as either “job loser/on layoff” or “other job loser”. Thus, in order to avoid breaks in the series we must group these codes together. This has little effect on our results, as “temporary job ended” is only given as the reason for around 10% of EU transitions in periods when it is available.

²⁹These are transitions where the reason for unemployment is “re-entrant” or “new entrant”. Such transitions account for 15-20% of all EU transitions.

³⁰In principle all individuals that make EN transitions should report having worked in the past 12 months. In practice many do not. One possible explanation is classification error. For example, Abowd and Zellner (1985) report that slightly more than 2 percent of individuals classified as “employed” have their employment status determined as “unemployed” or “non-participant” upon re-interview.

³¹These are the possible answers from before 1994. After 1994 we define such transitions analogously.

³²Other EN separations include retirements, disabilities, and the end of temporary seasonal or non-seasonal jobs.

decomposition. This gives us the time series of our decomposed EU and EN transition rates as shown in Figures 2 and 3.

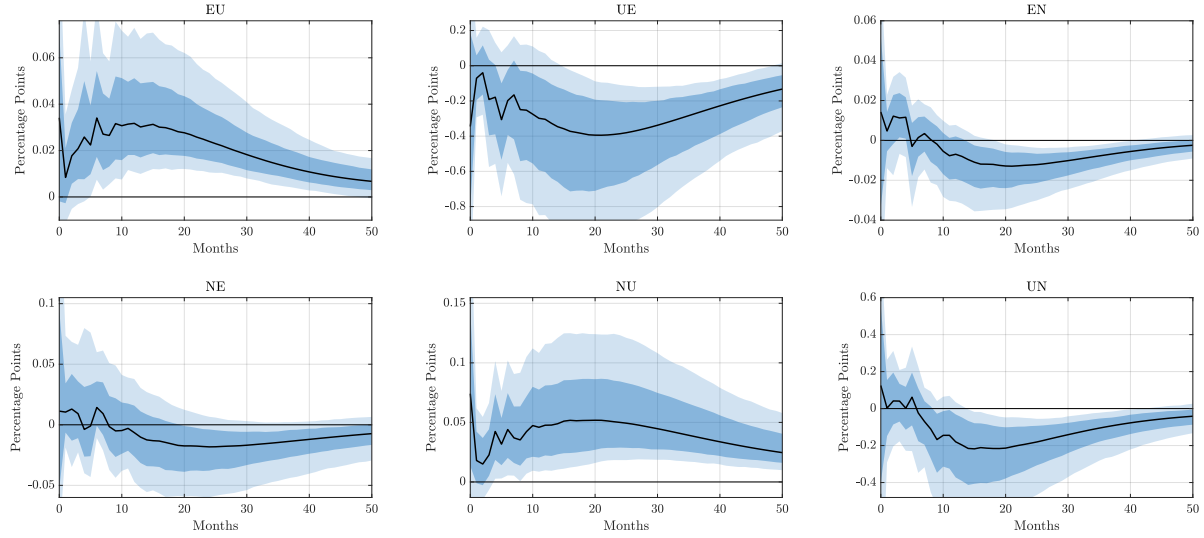
A.2. “Intensive Margin” of Labor Supply. Our measure of the “intensive margin” for unemployed workers is the number of distinct job search methods that they report. The re-design of the CPS in 1994 complicates the construction of a consistent series for this measure, as it increased the number of possible job search methods from 6 to 12. Consequently, we allow for 5 possible methods of active search: “contacted public employment agency”, “contacted private employment agency”, “contacted friends or relatives”, “contacted employer directly/interview” and “other active”. We then group the answers from pre- and post-1994 into these 5 categories and calculate the average number of search methods among unemployed individuals.³³

Our measure of the “intensive margin” for non-participants is the fraction of such individuals who report that they want a job. Before 1994, non-participants were only asked whether they wanted a job in the outgoing rotation group. The possible answers were “Yes”, “Maybe, it depends”, “No”, or “Don’t know”. From 1994 this question was asked to all non-participants and the possible answers were changed to “Yes, or maybe, it depends”, “No”, “Retired”, “Disabled”, or “Unable to work”. Given the change in possible answers, we group “Yes” and “Maybe, it depends” as “Yes” and all other answers as “No”. This gives us a consistent series over time that displays no break at the 1994 re-design.

³³In principle, “placed or answered ads” is a sixth method that is included both before and after 1994. However, we have found that the number of individuals reporting this method dropped sharply after 1994. This is likely explained by the introduction of “Sent out resumes/filled out applications” as a possible search method at this time.

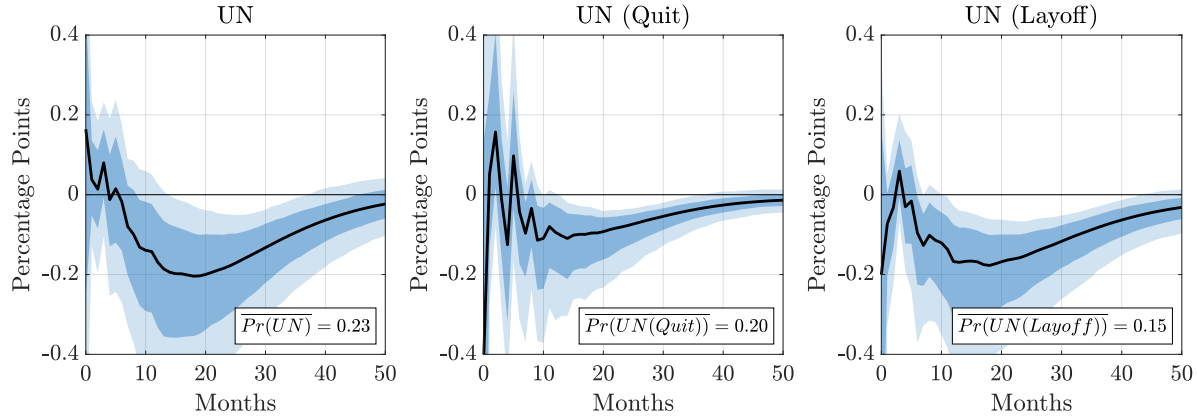
APPENDIX B. ADDITIONAL FIGURES

FIGURE B.1. Response of Labor Market Flows (Composition Adjusted)



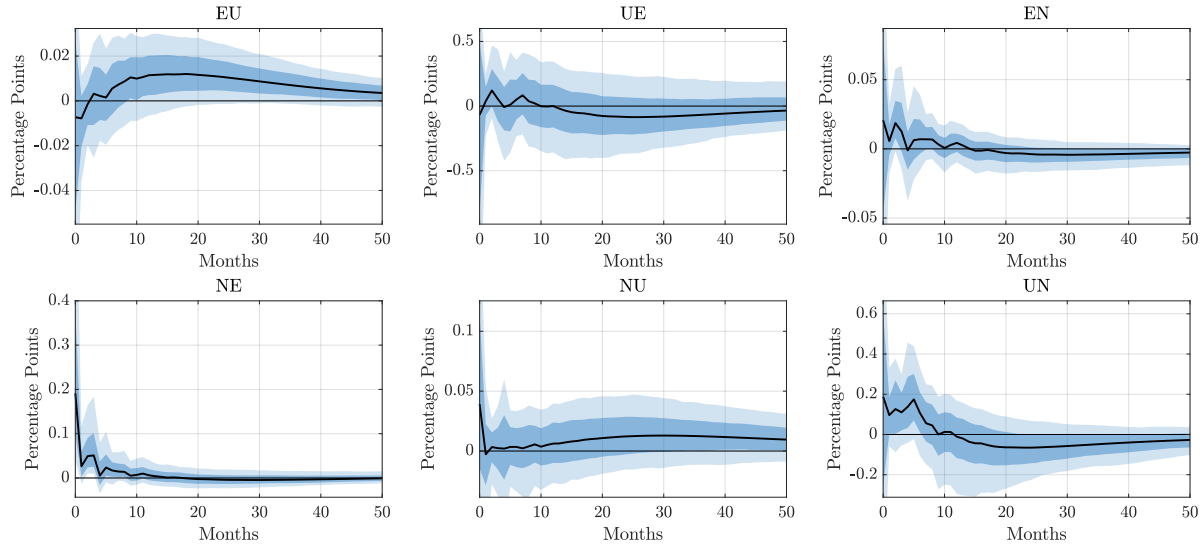
Note: We construct composition-adjusted flow rates holding fixed shares by age, gender and education, as in Table 5 of Elsby et al. (2015). The responses of the composition-adjusted IRFs for labor market flows are similar to those from our baseline, in Figure 6. We thus conclude that our baseline IRF is not driven by changes in the composition of workers across labor markets states in response to a contractionary monetary policy surprise, but instead reflects economic responses at the level of the individual.

FIGURE B.2. Response of UN Flows by Reason for Unemployment



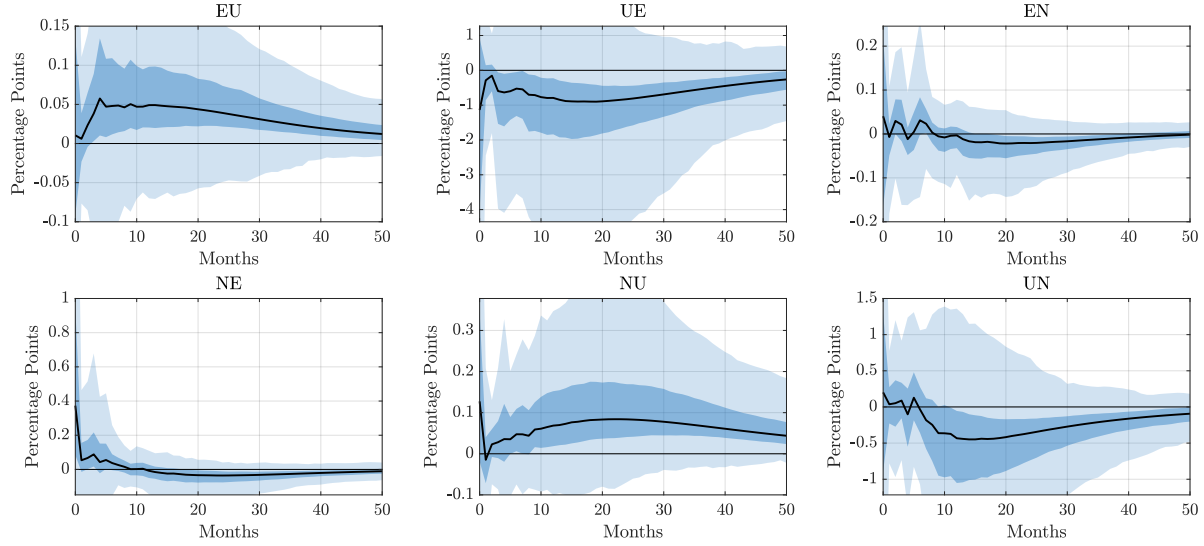
Note: We compute separate IRFs for UN flows by reason for unemployment to verify that the aggregate increase in UN flows is not an artifact of an increasing share of workers in unemployment due to layoff. The IRF for the total UN flow is very similar to that for the subgroup of the unemployed who have been laid off. Thus, our finding of diminished UN flows is not driven by cyclical changes in the shares of quits versus layoffs among workers in unemployment.

FIGURE B.3. Labor Market Flows: Non-Orthogonalized Shocks, No Chair Speeches



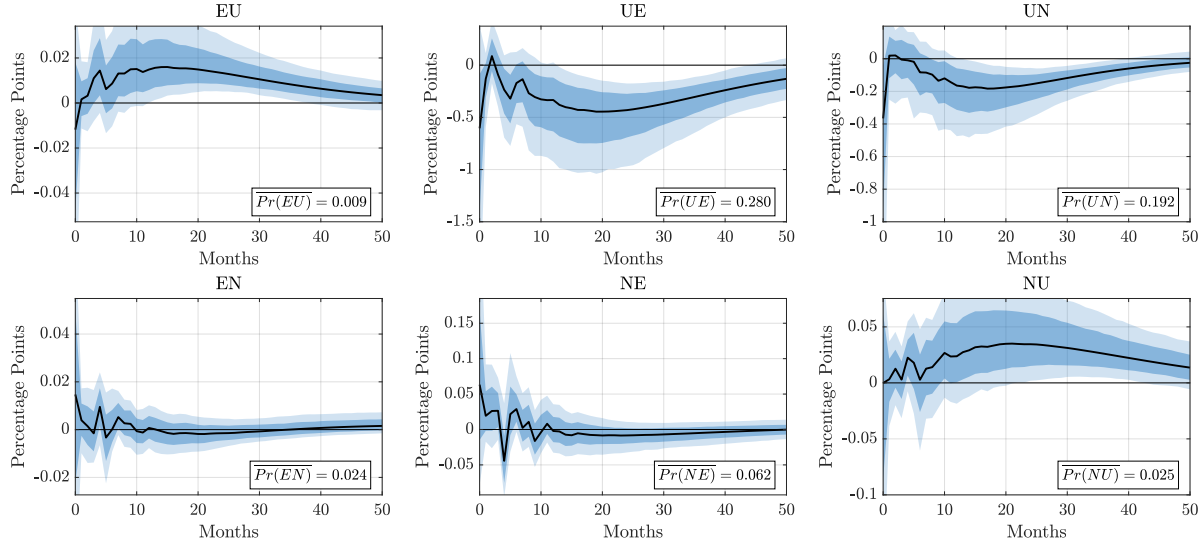
Note: Here, we estimate the response of labor market flows to a monetary policy shock using FOMC announcements that are not orthogonalized as in Bauer and Swanson (2023a,b). Compared to our baseline estimates from Figure 6, the recovered IRFs show a weaker response of labor market flows to a contractionary monetary policy surprise. None of the flows are significant at the 90% level, and only the response of EU and UN flows are significant at 68%.

FIGURE B.4. Labor Market Flows: Orthogonalized Shocks, No Chair Speeches.



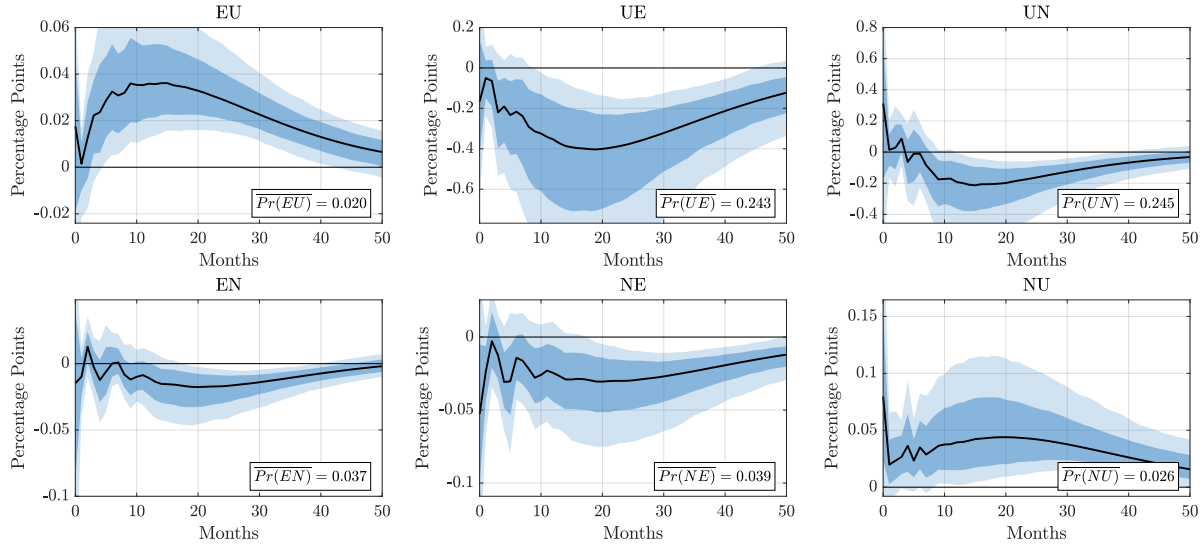
Note: We estimate the response of labor market flows to a monetary policy shock using FOMC announcements that are orthogonalized according to the procedure of Bauer and Swanson (2023a,b). Compared to Figure B.3, the IRFs here are larger in magnitude, indicating the importance of removing predictable components of the HFI shocks. However, orthogonalizing the HFI shocks reduces the first-stage F-static considerably and introduces a weak instruments problem. Thus, the confidence intervals for the IRFs are considerably wider than for our baseline specification that also includes Chair speeches.

FIGURE B.5. Labor Market Flows: College Educated



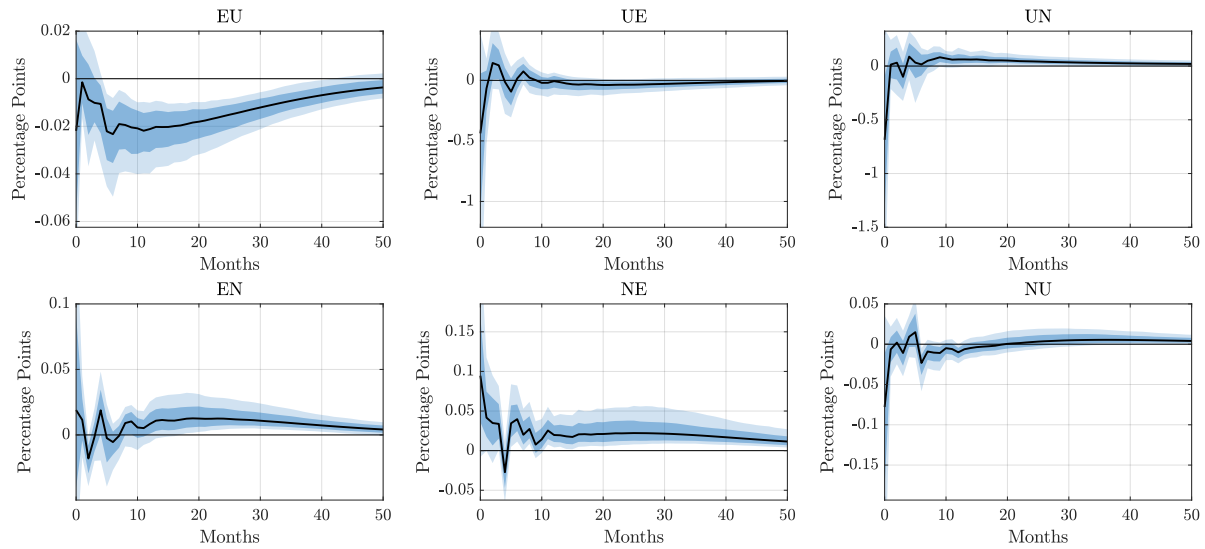
Note: Estimated impulse responses to a 25bp monetary policy tightening shock, computed by appending the given labor market flow variable to the baseline VAR from Figure 5. Solid black lines report impulse response functions while light- and dark-blue-shaded regions report bootstrapped 68% and 90% standard error bands. See text for details.

FIGURE B.6. Labor Market Flows: High School Educated



Note: Estimated impulse responses to a 25bp monetary policy tightening shock, computed by appending the given labor market flow variable to the baseline VAR from Figure 5. Solid black lines report impulse response functions while light- and dark-blue-shaded regions report bootstrapped 68% and 90% standard error bands. See text for details.

FIGURE B.7. Labor Market Flows: College - High School



Note: Estimated impulse responses to a 25bp monetary policy tightening shock, computed by appending the given labor market flow variable to the baseline VAR from Figure 5. Solid black lines report impulse response functions while light- and dark-blue-shaded regions report bootstrapped 68% and 90% standard error bands. See text for details.

APPENDIX C. MODEL APPENDIX

Using equations (9) and (10) for the values of non-employment and employment, write the worker surplus $V_1(b) - V_0(b)$ as

$$V_1(b) - V_0(b) = \frac{w - \frac{b - \mathbb{I}\{s=1\} \cdot \psi}{\mu} + \chi \cdot \int_{\underline{b}}^{\bar{b}} (\max \{V_1(b'), V_0(b')\} - V_0(b')) dF(b')}{r + \delta + [(1 - \alpha) + \alpha \cdot \mathbb{I}\{s = 1\}] \cdot \lambda + \chi}$$

Then, taking V_0^s as the value of non-employment when searching ($s = 1$) is optimal and V_0^{ns} as the value of non-employment when not searching ($s = 0$) is optimal, write

$$V_1(b) - V_0^s(b) = \frac{w - \frac{b - \psi}{\mu} + \chi \cdot \int_{\underline{b}}^{\bar{b}} (\max \{V_1(b'), V_0(b')\} - V_0(b')) dF(b')}{r + \delta + \lambda + \chi}, \quad (\text{C.1})$$

and

$$V_1(b) - V_0^{ns}(b) = \frac{w - \frac{b}{\mu} + \chi \cdot \int_{\underline{b}}^{\bar{b}} (\max \{V_1(b'), V_0(b')\} - V_0(b')) dF(b')}{r + \delta + (1 - \alpha) \cdot \lambda + \chi} \quad (\text{C.2})$$

Finally, define V_0^{na} to be the value of non-employment when not accepting a job is optimal, i.e., $V_0^s = \max \{V_0^s, V_0^{ns}\}$ so that

$$V_1(b) - V_0^{na}(b) = \frac{w - \frac{b}{\mu} + \chi \cdot \int_{\underline{b}}^{\bar{b}} (\max \{V_1(b'), V_0(b')\} - V_0(b')) dF(b')}{r + \delta + \chi} \quad (\text{C.3})$$

Thus,

$$V_1(b) - V_0(b) = \max \{V_1(b) - V_0^s(b), V_1(b) - V_0^{ns}(b), V_1(b) - V_0^{na}(b)\} \quad (\text{C.4})$$

Clearly, $V_1(b) - V_0(b)$ is strictly decreasing in b . Then, it is easy to see that $V_0(b)$ is strictly increasing in b . Given appropriate assumptions about the support $[\underline{b}, \bar{b}]$, $\exists Q \in (\underline{b}, \bar{b})$ s.t. $V_1(Q) - V_0^{ns}(Q) = 0$ and $S \in (\underline{b}, \bar{b})$ s.t. $V_0^s(S) - V_0^{ns}(S) = 0$.³⁴ Solve for S such that $V_0^{ns}(S) = V_0^s(S)$:

$$\frac{\psi}{\mu} = \alpha \cdot \lambda (V_1(S) - V_0^s(S)) \quad (\text{C.5})$$

Then, solve for Q such that $V_0^{ns}(Q) = V_1(Q)$:

$$Q = \mu \left(w + \chi \int_{\underline{b}}^Q (V_1(b') - V_0(b')) dF(b') \right) \quad (\text{C.6})$$

Corollaries 1 and 2 follow.

To prove Proposition 1, set $\chi = 0$, substitute equation (C.1) into (C.5), and then simplify to obtain (13). Solving for S , we obtain

$$S = \mu w - \frac{(\rho + \delta + (1 - \alpha)\lambda)\psi}{\alpha\lambda} \quad (\text{C.7})$$

³⁴Note, $S < Q$; otherwise, agents would make strictly positive gains from not searching.

Take derivatives with respect to μ and λ :

$$\frac{\partial S}{\partial \mu} = w \quad (\text{C.8})$$

$$\frac{\partial S}{\partial \lambda} = \frac{(\rho + \delta)\psi}{\alpha\lambda^2} \quad (\text{C.9})$$

Both $\partial S/\partial \mu$ and $\partial S/\partial \lambda$ are strictly positive.

Recall, non-employed workers with $b \in [\underline{b}, S]$ engage in active search. We associated a contractionary monetary policy shock with a decline in the aggregate job-finding probability λ and an increase in the marginal utility of consumption μ . Thus, a contractionary monetary policy shock *decreases* participation through the decline on the job-finding probability λ , operating through a substitution effect; and *increases* participation through the increase in the marginal utility of consumption μ , operating through an income effect.

Finally, evaluating equation (C.6) at $\chi = 0$, an increase in the marginal utility of consumption will increase the quit threshold Q , thereby reducing the mass of employed workers in $[Q, \bar{b}]$ who will optimally quit from their job; whereas Q does not respond to changes in the job finding rate. Note, however, that the surplus $V_1(b) - V_0(b)$ is decreasing in the job finding rate for $b \in [\underline{b}, Q]$. Thus, if $\chi > 0$, Q will be increasing in λ through second term on the right side of (C.6) reflecting the option value of employment. This is seen in Figure 20, where we do not restrict χ to be equal to zero.