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. Estimating the response of labor market flows to high-frequency changes in interest rates around FOMC announcements and Fed Chair speeches, we find that a contractionary monetary policy shock leads 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 constant, the overall decline in employment from a contractionary monetary policy shock 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 holds that monetary policy primarily influences labor demand and has little effect on labor supply. This view is incorporated into the traditional "old" Keynesian framework, as discussed by Gali (2013). Such a view is also echoed in statements by monetary policymakers, including the beginning of the quote above from Fed Chair Jerome Powell. Finally, this consensus is reflected in the research frontier of the New Keynesian literature, where the standard assumption of sticky wages under a neoclassical labor market clearing condition precludes any significant quantitative role for labor supply in shaping the response of employment to a monetary policy shock.[1]

In contrast to the consensus view, we offer new empirical evidence of a substantial labor supply response to monetary policy. Using high-frequency changes in interest rates around both FOMC announcements and Fed Chair speeches to estimate the response of labor market flows to monetary policy, we show that a contractionary

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[1]Broer et al. (2020) and Auclert, Bardóczy and Rognlie (2021) offer detailed discussions of this property of the sticky-wage NK model. See also the discussion of the related literature below.

monetary policy shock generates quantitatively important increases in labor supply; both by decreasing the rate at which workers quit jobs to non-employment, and by stimulating job-seeking behavior among the non-employed. Thus, our findings indicate that a contractionary monetary policy shock does indeed support (i.e., increase) labor supply, moderating the overall decline in employment from a surprise monetary tightening.

To quantify the contribution of supply-driven labor market flows to the employment response to a contractionary monetary policy shock, we extend a standard flow-based accounting framework à la Shimer (2012) and Elsby, Hobijn and Şahin (2015). 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 at their steady state values.

We begin by identifying labor market 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 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.[2] One contribution of our paper is to provide new evidence that a large and procyclical component of flows between employment (E) and nonparticipation (N) is due to worker-initiated quits.

We estimate the response of labor market flows to exogenous variation in monetary policy by extending a standard monetary structural vector autoregression (SVAR). Following Kuttner (2001) and Gertler and Karadi (2015), we identify the effects of monetary policy on the economy and labor market activity using high-frequency changes in interest rate futures around FOMC announcements as an external instrument. Crucially, we also employ the recent methodology of Bauer and Swanson (2023b) to improve the validity and exogeneity of our external instruments, in part from exploiting additional interest rate variation around Fed Chair speeches. As such, we offer substantially more accurate estimates of the response of labor market flows to monetary policy shocks than available in the existing literature.[3]

Consistent with the consensus view described above, our VAR analysis shows that flows from E to U increase following a monetary policy tightening, and flows from U to E decrease, consistent with a weakening economy and lower labor demand. But, in contradiction to the consensus view, we also show that flows from N to U significantly increase following the monetary policy tightening, and flows from U to N decrease,

[2]The designation of labor supply flows that we consider here is similar to that considered for separate applications elsewhere in the literature, e.g., Krusell et al. (2017).

[3]An alternative approach to using HFI monetary policy shocks is to use narrative shocks à la Romer and Romer (2004). As discussed by Ramey (2016), however, these shocks exhibit a form of sub-sample instability: if the sample begins after 1982—into the start of Volcker disinflation—contractionary monetary policy shocks appear to have expansionary effects. We have found similar problems in studying the response of labor market flows to these shocks.

consistent with heightened job search from non-employment, and thus an increase in labor supply.[4]

Of course, a household might also increase their labor supply in response to a monetary contraction by delaying quits from employment to non-employment. But any such reduction in flows from employment to non-employment might be obscured by a concurrent increase in layoffs. We use additional survey data to clarify how separations to non-employment variously reflect layoffs and quits. While a large portion of flows from employment to unemployment (EU) are known to be accounted for by countercyclical layoffs, we offer new evidence that a dominant portion of flows from employment to nonparticipation (EN) can be accounted for by procyclical quits. Then, in our VAR analysis, we show that, although layoffs rise in response to a contractionary monetary policy shock, quits to nonparticipation fall, offering further evidence of labor supply increasing in response to monetary tightening.

We thus find significant evidence that the conventional wisdom described above is not correct: monetary policy generates a considerable labor supply response. The labor supply response that we document is consistent with that of an income effect, where 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.

To quantify the importance of the increase in labor supply to a contractionary monetary policy shock, we build upon the methodology of Shimer (2012) and Elsby, Hobijn and Şahin (2015). In particular, we construct hypothetical impulse responses of labor market stocks where we hold a candidate labor market flow constant at its steady-state value, allowing us to quantify the contribution of that flow towards the entire impulse response of the labor market stock under consideration. Holding the response of supply-driven labor market flows fixed, the response of employment to a contractionary monetary policy shock becomes almost twice as large. Thus, our results indicate an important role for increased labor supply in attenuating the demand-driven decline in employment from a contractionary monetary policy shock.

To better understand why an individual might increase their labor supply in response to a contractionary monetary policy shock, we separately study the labor supply responses of lower– and higher-educated workers. Lower-educated workers typically hold fewer assets by which to smooth consumption in the face of a monetary contraction; and we offer new evidence that lower-educated workers suffer greater employment losses from a contractionary monetary policy shock, primarily due to a larger increase in layoffs.[5] Thus, to the extent that an increase in labor supply from a contractionary monetary policy shock can be understood through an income effect

[4]We find similar evidence of labor supply increases to a contractionary monetary policy shock on the intensive margin of job search: non-participants are more likely to report that they want to work, while unemployed individuals use more search methods to find a job.

[5]See Broer, Kramer and Mitman (2021) and Faia et al. (2022) for complementary findings of heterogeneity by income in the responsiveness of EU flows to a monetary shock.

(as hypothesized above), we should expect a larger labor supply response from lower-educated workers. Our estimates confirm this indeed to be the case: in the wake of a contractionary monetary policy shock, lower-educated workers increase their labor supply substantially more than higher-educated workers, driven in part by a greater decrease in quits to non-employment.[6]

Thus, our estimates reveal a quantitatively important role for labor supply in shaping the overall employment response to a monetary policy shock, consistent with a role for an income effect in determining labor supply. Moreover, our findings highlight 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 labor supply.

Although our results show a sizeable labor supply response to a monetary policy shock, sticky-wage NK models at the research frontier typically rule out any role for labor supply, as discussed by Broer et al. (2020). Thus, although the NK literature increasingly emphasizes the importance of heterogeneity in the consumption response to a monetary policy shock in accounting for the aggregate effect of monetary policy, models at the forefront of the literature necessarily abstract from the heterogeneity in labor supply responses documented here. Yet, heterogeneity in labor supply responses may be of similar importance to heterogeneity in consumption responses for understanding the aggregate effects of monetary policy. For all these reasons, incorporating a role for labor supply into the sticky-wage NK model may constitute an important avenue for future research.

We take a first step in this direction, showing that the essential features of our estimates can be understood within a simple model of frictional labor markets with endogenous labor force participation à la Krusell et al. (2017). As we show, the potential responses of non-employed workers in the model to a contractionary monetary policy shock accommodates both a substitution effect—whereby a reduction in the job-finding rate moves workers from unemployment to nonparticipation—but also an opposing income effect—whereby the increase in the marginal utility of consumption reduces the consumption-equivalent value of leisure and moves workers from non-participation to unemployment. To be consistent with our findings of heightened job-seeking among the non-employed after a contractionary monetary policy shock, the income effect must dominate.

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 hypothetical impulse response functions from when we shut down each

[6]Our results are distinct but complementary to those of Cantore et al. (2023), who find evidence of an increase in hours worked to a contractionary monetary policy shock among low-income workers who remain in employment.

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. We also differ from this literature in our additional focus on the response of labor market flows to identified monetary policy shocks.

In terms of our focus on flows between unemployment and nonparticipation, we build on the work of Elsby, Hobijn and Şahin (2015). While they study 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 are quantitatively more important for employment dynamics than for unemployment dynamics. We offer a further contribution in documenting the importance of quits from employment to nonparticipation as an additional and equally important supply-related flow.

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), Coglianese, Olsson and Patterson (2022), and Faia et al. (2022).

We contribute to this developing literature in part 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 estimates confirm that many labor market flows respond to monetary policy shocks in a way that appears consistent with their unconditional cyclical dynamics. Thus, we view our estimates of the conditional response of labor market flows to a single shock—in this case, a shock to monetary policy—as useful for understanding how these same flows evolve unconditionally over the business cycle, where their behavior potentially reflects responses to multiple shocks.

However, we also uncover some important differences: First, whereas flows from E to U show only transitory increases at the beginning of a recession, we estimate highly persistent increases in EU flows in response to a contractionary monetary policy shock. Indeed, our analysis reveals 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.[7]

Second, while job-to-job transitions fall at the beginning of recessions, our estimates show virtually no response of these same flows to a contractionary monetary shock. Thus, our findings do not offer independent support for the "offer-matching theory of inflation," where the rate of job-to-job transitions is taken to be an important measure of labor market slack, e.g., Birinci et al. (2022), Moscarini and Postel-Vinay (2022), and Faccini and Melosi (2023).

Third, other authors conclude that the unconditional cyclical behavior of certain labor market flows can largely be understood as reflecting cyclical changes in the composition of workers across labor market states, e.g., Elsby, Hobijn and Şahin (2015). Applying the same methodology, we verify that our estimates for the response of labor market flows to monetary policy shocks 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 can be used to understand variation in labor supply at the individual level.

Our paper is more broadly related to the literature on monetary policy VARs and high-frequency identification, such as Kuttner (2001), 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.

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. Thus, households show no labor supply response to aggregate and idiosyncratic shocks, instead providing whatever labor is demanded by the production

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

Table 1. Cyclicality 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.

sector.[8] A similar absence of a role for labor supply is reflected in the smaller literature studying New Keynesian models that incorporate equilibrium unemployment, but assume perfectly inelastic labor supply, 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);

[8]Broer et al. (2020) demonstrate this as a robust characteristic of both the representative agent and heterogeneous agent sticky-wage New Keynesian model under frictionless labor markets: Under a conventional calibration for parameters determining the overall degree of wage stickiness, wages show very little response to a monetary policy shock, and thus "labour usage is 'demand-determined' " (pg. 98). Huo and Ríos-Rull (2020) and Broer et al. (2023) offer further discussion of demand-determined labor under wage stickiness.

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, Patterson and Şahin (2018), this rate is the extensive margin of job search activity. This measure will feature prominently in our analysis as a reflection of the cyclicality 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:

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

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

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

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.[9] Table 3 summarizes the cyclical properties of each of the six HP-filtered off-diagonal transition probabilities. The full time series of transition

[9]We 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

	To		
From	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. Cyclicality 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.

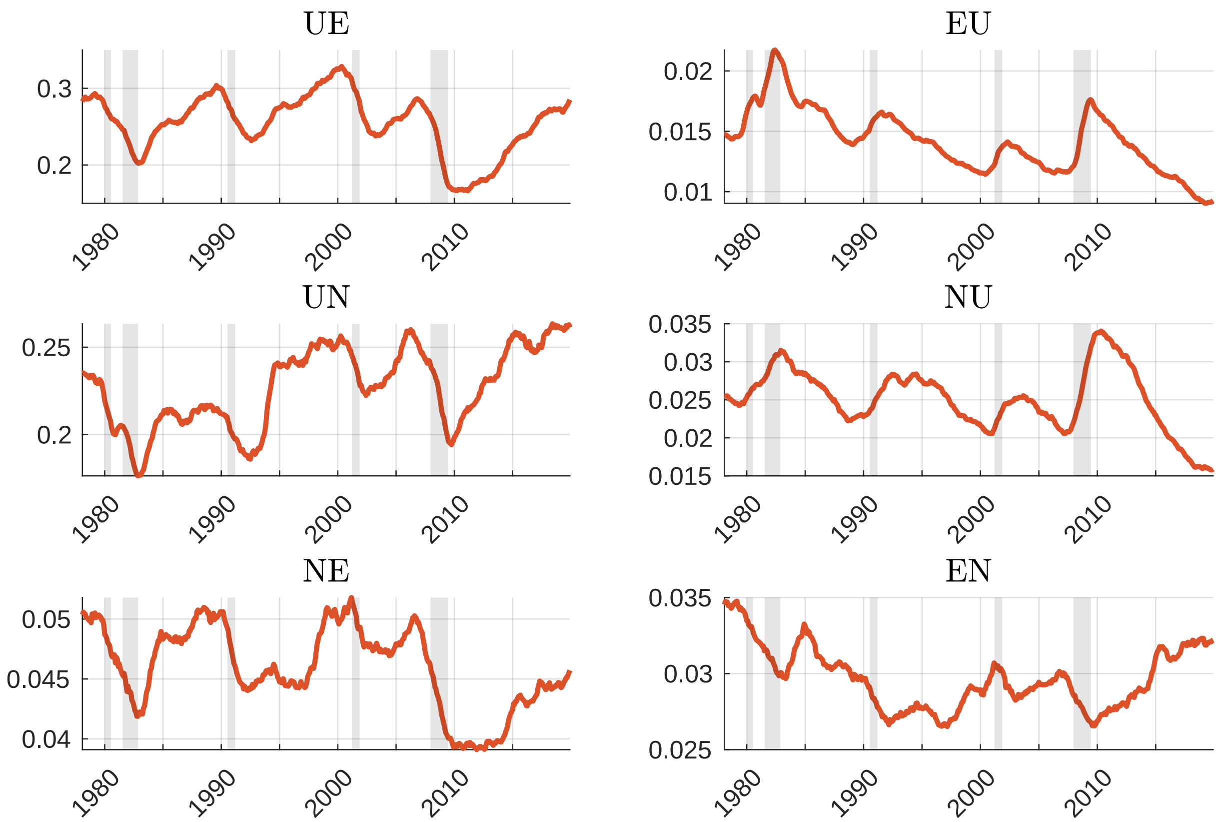
probabilities for our sample is plotted in Figure 1.[10] The properties of these transition probabilities have been well documented in the literature (e.g., Shimer, 2012; Elsby et al., 2015; Krusell et al., 2017). Here we simply note that we will consider flows between nonparticipation and unemployment 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, Hobijn and Şahin (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

[10]For 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

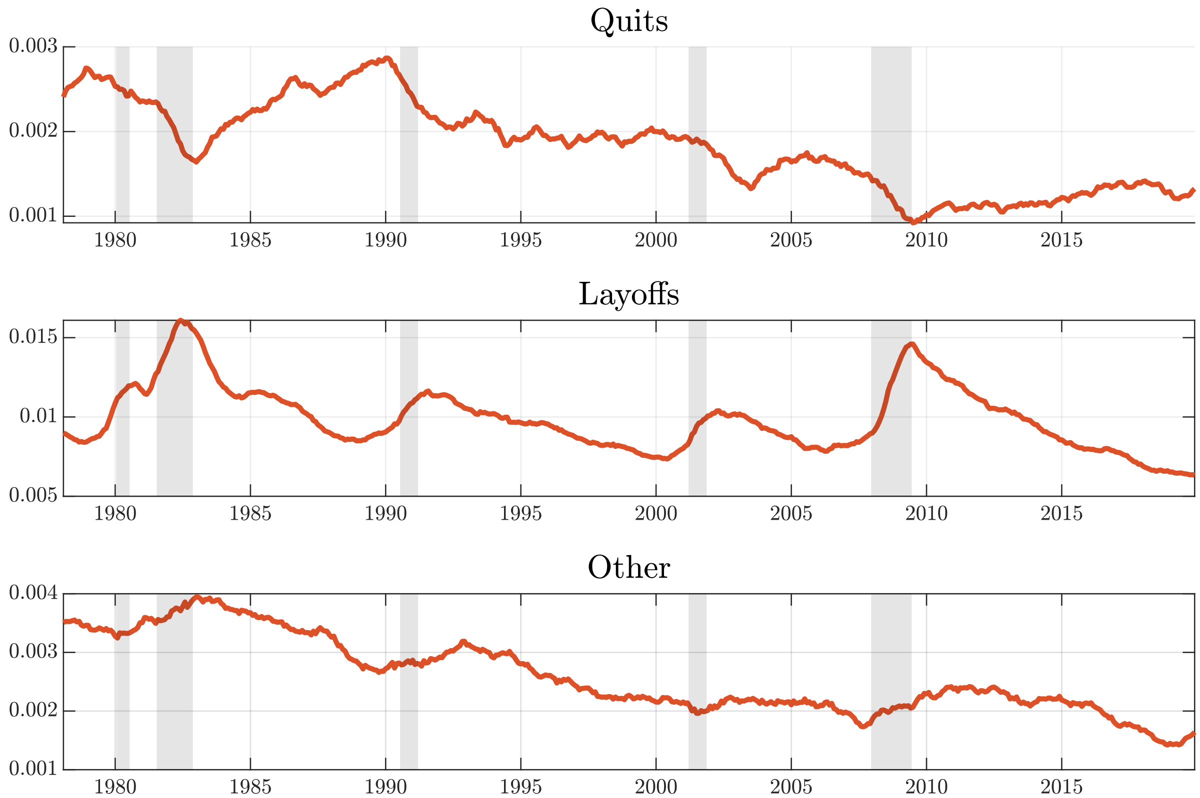


unemployment in the CPS as being a "job leaver", then we classify that transition as a quit, while if they report being a "'job loser/on layoff", we classify that transition as a layoff. Additional details are provided in Appendix A.1. We interpret layoffs as being driven by factors related to labor 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 cyclicality 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
$\text{std}(x)/\text{std}(Y)$	5.16	8.16	7.88	6.26
$\text{corr}(x, Y)$	-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
std(x)/std(Y)	2.47	5.89	14.46	4.61
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, Michaels and Solon (2009) and Ahn (2023).

Although a considerable literature studies the cyclicality 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.[11] 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.[12]

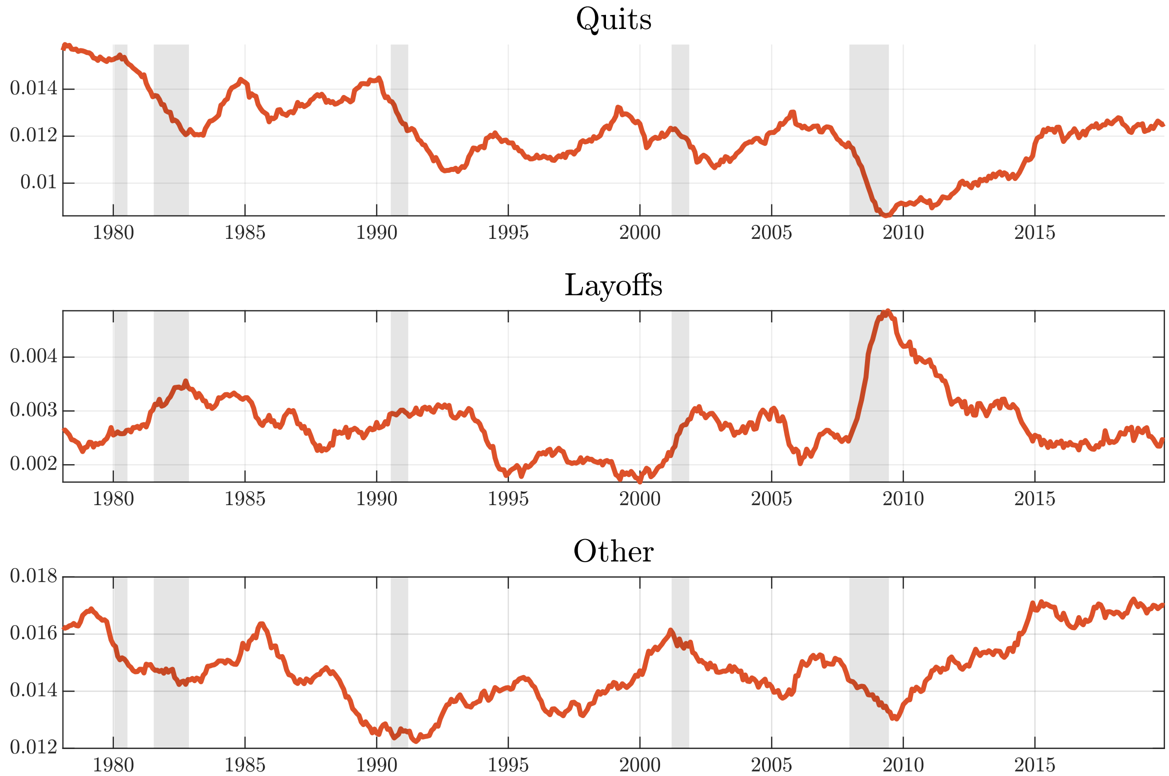
Hence, the observed procyclicality of EN flows can be accounted for by the tendency of workers to quit to nonparticipation rather than to unemployment. The portion of EN flows that can be identified as quits is economically significant and of similar magnitude to the entirety of EU flows.

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 cyclicality of quits to non-employment than has been previously recognized.

[11]As 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.

[12]Faberman 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, Hobijn and Sahin (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, Schoefer and Zweimüller (2022) and Davis and Krolikowski (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 the 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, Patterson and Şahin (2018). Mukoyama, Patterson and Şahin (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.[13]

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., Kuttner, 2001; 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.[14] 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,

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

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

[14]Industrial 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,

$$u_t = S\varepsilon_t, \tag{4}$$

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.[15] In order for z_t to be a valid instrument for ε_t^{mp}, it must satisfy an instrument *relevance* condition,

$$E[z_t \varepsilon_t^{mp}] \neq 0, \tag{5}$$

and an instrument *exogeneity* condition,

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

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

[15]High-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.[16] 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).[17]

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

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

via two-stage least squares, using z_t as the instrument for Y_t^{2y}.[18] 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 shaded regions report bootstrapped 68% and 90% confidence intervals, computed as in Jentsch and Lunsford (2019).

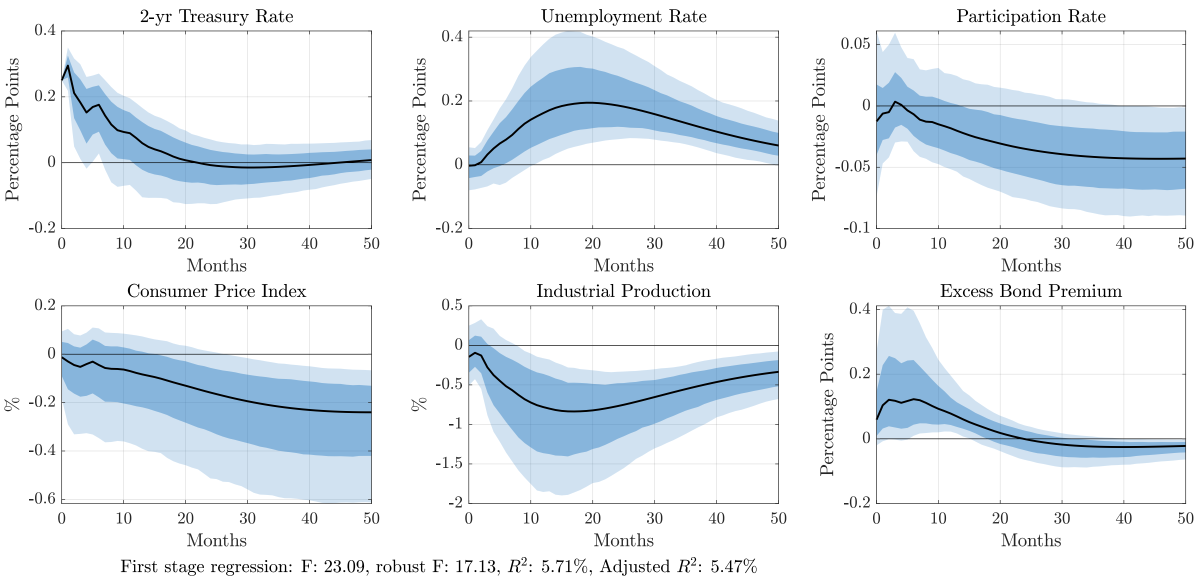
The impact effect of a monetary policy shock on the 2-year Treasury yield is normalized to a 25bp tightening. After impact, the 2-year Treasury yield increases

[16]Note 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.

[17]Swanson 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.

[18]One 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

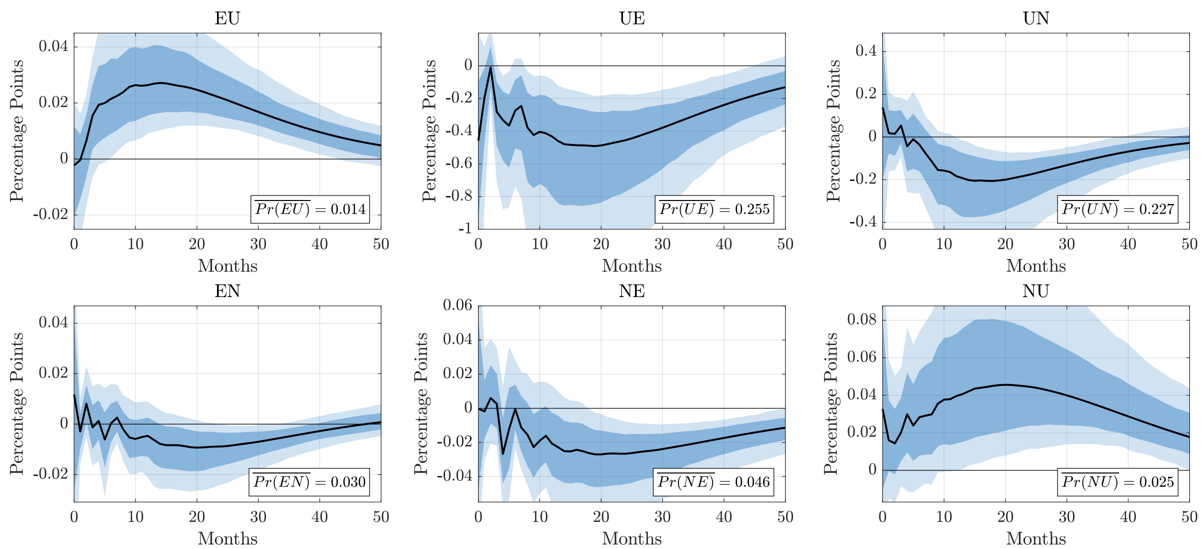


Note: Estimated impulse responses to a 25bp monetary policy tightening shock in the baseline VAR. Solid black lines report impulse response functions, while dark and light shaded regions report bootstrapped 68% and 90% confidence intervals. See text for details.

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.[19]

[19]Note 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 dark and light shaded regions report bootstrapped 68% and 90% confidence intervals. 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.[20] 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 consistent with a decline in labor demand given the weakening aggregate economy. This increase may seem small at first glance—about 0.025

[20]IRFs 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.

percentage points at its peak—but it is sizeable relative to the steady-state flow of about 1.4 percent each month (as reported in the inset box). Moreover, the increase in EU flows in response to an identified monetary policy shock is highly persistent, especially compared to the more transitory increase in EU flows seen at the start of a recession, e.g., Elsby et al. (2009).

The response of the flow from unemployment to employment (UE) in the top middle panel of Figure 6 is similarly consistent with a decline in aggregate demand: 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.[21] 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.

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 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.

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.

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

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.

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.

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.

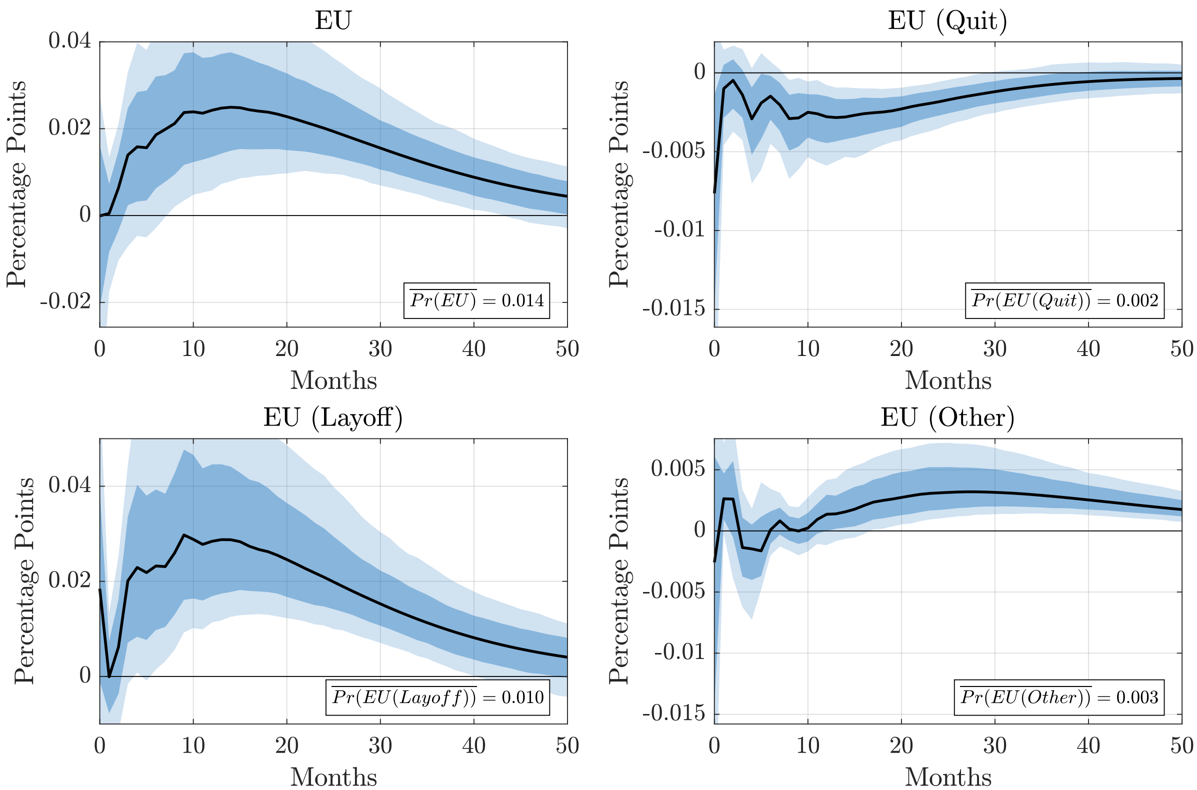
Figure 7 shows a decomposition of the IRF for flows from employment to unemployment (EU) in response to a 25bp monetary policy tightening. The small portion of EU flows associated to quits decrease in response to the contractionary monetary surprise, whereas the larger portion associated to layoffs increase.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

Figure 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.[22]

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

[22]While 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.

FIGURE 7. Decomposition of E-U Response

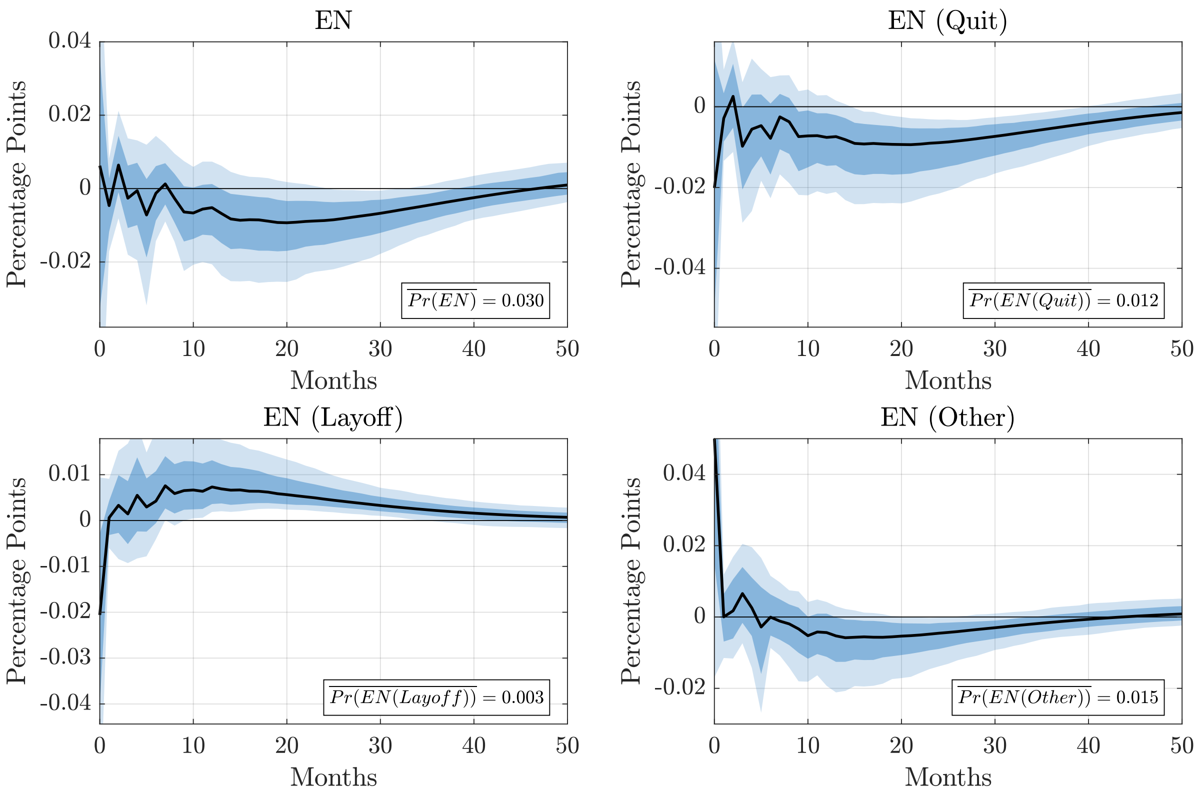


Note: Estimated impulse responses to a 25bp monetary policy tightening shock, computed by appending the given labor market flow variable to the baseline VAR from Figure 5. Solid black lines report impulse response functions while dark and light shaded regions report bootstrapped 68% and 90% confidence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

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 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.

Figure 8. Decomposition of E-N Response

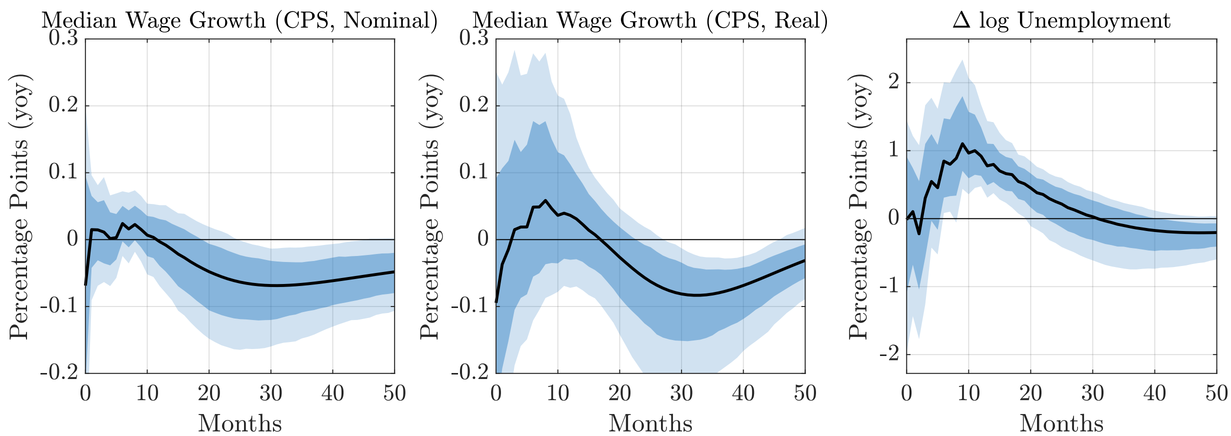


Note: Estimated impulse responses to a 25bp monetary policy tightening shock, computed by appending the given labor market flow variable to the baseline VAR from Figure 5. Solid black lines report impulse response functions while dark and light shaded regions report bootstrapped 68% and 90% confidence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

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 Krolikowski (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).

FIGURE 9. Response of Wages and Unemployment



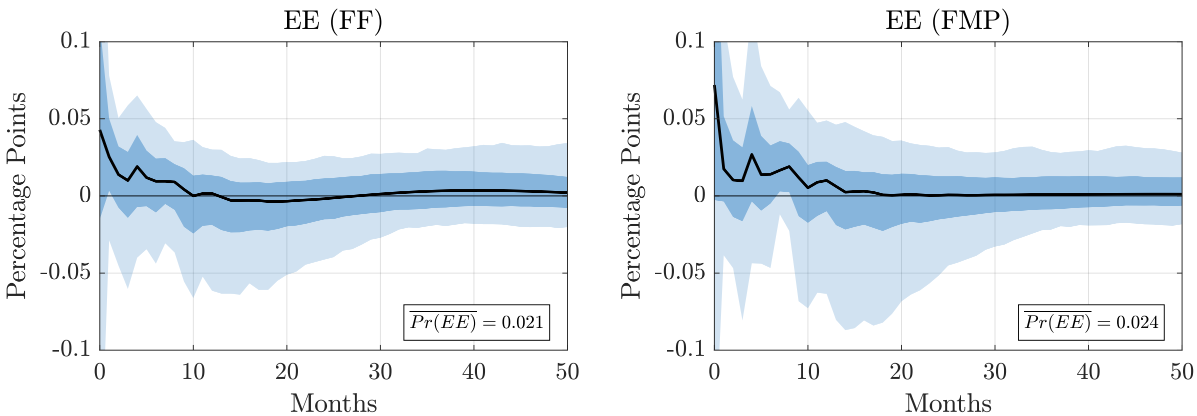
Note: Annual (hourly) wage growth is calculated using employed individuals in the outgoing rotation groups of the CPS. We add the median value of nominal and real wage growth to the baseline VAR. For unemployment, we replace the level of unemployment in the baseline VAR with the annual log change for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

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 ups 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 study 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 might appear inconsistent with the offer-matching theory of inflation, as we cannot reject a null response of job-to-job transitions to a contractionary monetary policy shock. We speculate that the flat IRFs of job-to-job transitions might in part reflect a problem of measurement: neither the

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 dark and light shaded regions report bootstrapped 68% and 90% confidence intervals. 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.

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 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. Thus, 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.[23]

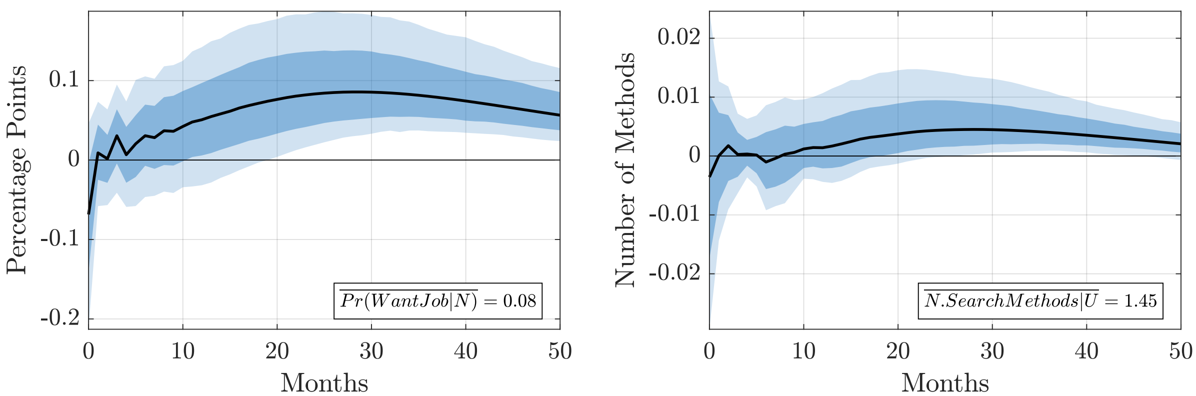
Notwithstanding these caveats, however, our estimates fail to provide independent support for the theory that offer-matching across employers competing for workers is an important driver of inflation.

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.

[23]Another 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 dark and light shaded regions report bootstrapped 68% and 90% confidence intervals. See text for details.

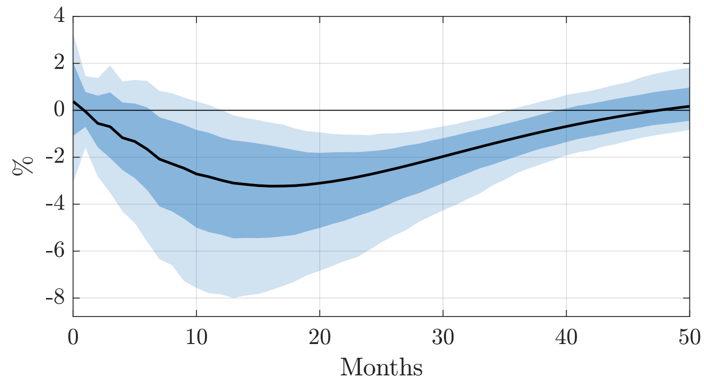
Here, we examine the response of the intensive margins of labor supply to a monetary policy surprise. Such responses are not associated with a change in the labor market status of a worker, but reflect an increased desire to work and may influence the rate at which workers move to employment.

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 no desire to work.[24] 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, Patterson and Şahin (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

[24]Non-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).

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. 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. Flow-based accounting for the dynamics of labor market stocks

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 the response of various labor market stocks such as unemployment, the employment-population ratio, and labor force participation are driven by the response of various underlying flows. To account for the contribution of a particular flow towards the overall response of a labor market stock to a monetary policy shock, we consider the hypothetical response of the stock when we hold response of the particular flow fixed, relying on equation (1), which expresses the evolution of aggregate labor market stocks as a function of labor market flows. Following the logic of Shimer (2012) and Elsby, Hobijn and Şahin (2015), to the extent that the implied response of the hypothetical stock deviates from that of the actual stock, we conclude that the flow in question plays an important role in shaping the overall response of the stock.

We develop two main findings. First, we uncover a more important role for cyclical variation in flows from employment to unemployment (i.e., layoffs) in determining the response of unemployment to a monetary policy shock than is typically found in the literature studying unconditional business cycle variation, e.g., Elsby, Michaels and Solon (2009) and Shimer (2012). Second, we show that the increase in supply-related labor market flows in response to a monetary policy shock attenuates the decline in employment by roughly one-half. We interpret this finding as revealing an important role for labor supply considerations in shaping the response of employment to a monetary policy shock.

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 remains 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).[25]

We now use the accounting 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), Furlanetto and Groshenny (2016), and Gagliardone and Gertler (2023).

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 hypothetical 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, $u_t = U_t/(U_t + E_t)$. We perform the procedure for each of the given six flows across the three distinct labor market states.

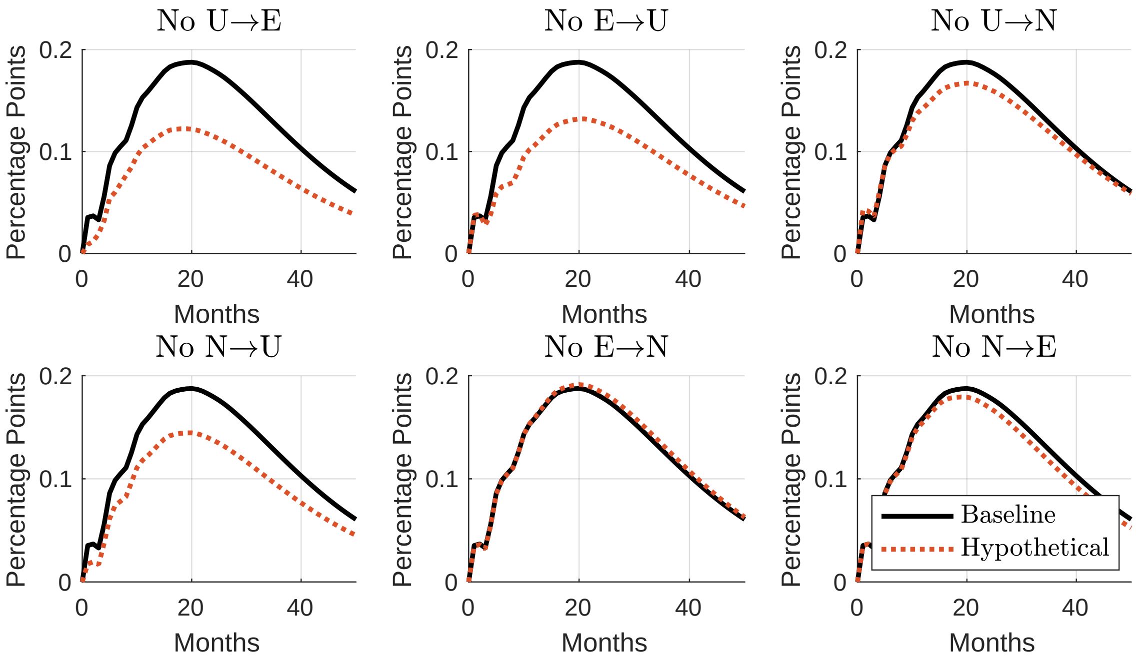
The hypothetical impulse responses are plotted in Figure 13. The solid black lines show the IRFs for unemployment estimated from our baseline VAR. The dotted red lines shows the hypothetical IRFs generated when we "turn off" the response of a given transition probability to the monetary policy surprise. 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 cyclicality 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.

[25]Some 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

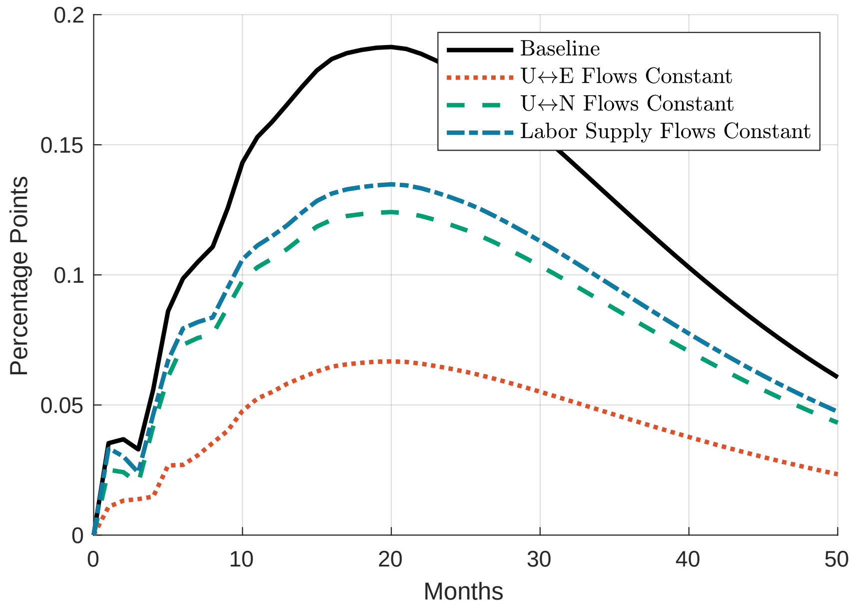


Note: The black solid line shows overall response of the unemployment rate to a contractionary monetary policy shock. The red dotted lines show the response if we hold individuals flow rates constant.

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, UN, and EN flows reflect supply considerations—Figure 13 might thus be interpreted as evidence that labor supply flows are relatively inconsequential for understanding the overall 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.

FIGURE 14. Flow-Based Accounting for Unemployment



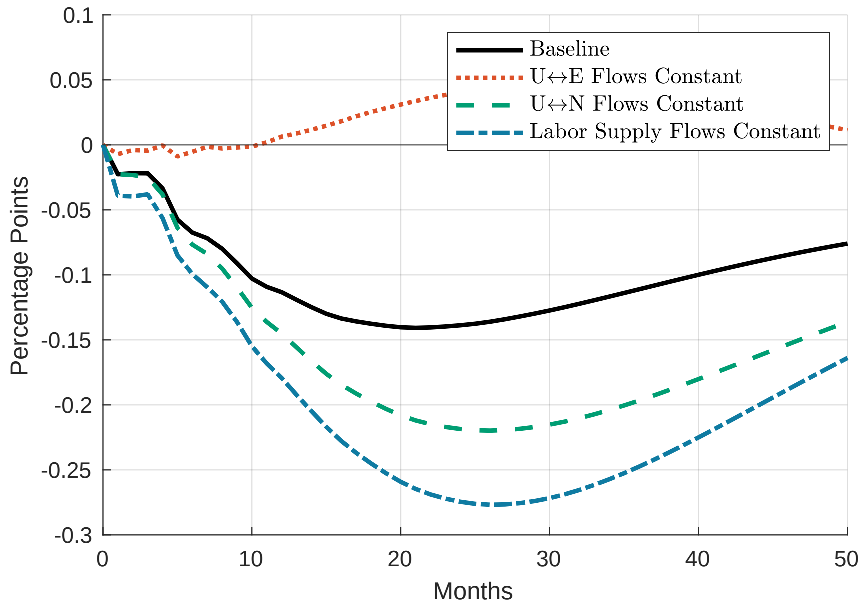
Note: "Labor Supply Flows Constant" shuts down the response of flows between U and N as well as the response of quits from employment to U or N.

In this section, we study how the responses of unemployment, the employment-population ratio, the labor force participation rate, and the search rate from non-employment to monetary policy surprises are shaped by flows associated with various labor demand and supply channels. We find that the increase in labor supply from a contractionary monetary policy shock plays a quantitatively important role in moderating the overall decline in employment.

We begin by studying the unemployment rate in Figure 14, where we shut down flows between E and U (E↔U); flows between U and N (U↔N); and the full labor supply response, which we identify as flows between U and N plus quits to non-employment.[26] Given the discussion of the previous section, it should come as no surprise that the U↔E to a monetary policy surprise accounts for the majority of the increase in unemployment. The removal of U↔N flows lowers the response of unemployment by one third, consistent with the findings of Elsby, Hobijn and Şahin

[26]Elsby, Hobijn and Şahin (2015) study how unemployment and labor force participation would evolve across the 1980s and 2008 recessions by similarly shutting down E↔U and U↔N flows. We follow their study as close as possible for ease of comparison. We analyze the labor supply response, U↔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 hypothetical stocks removing E↔U shut down much of the labor demand response (but exclude the labor demand effect on NE rates).

FIGURE 15. Flow-Based Accounting for Employment



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.

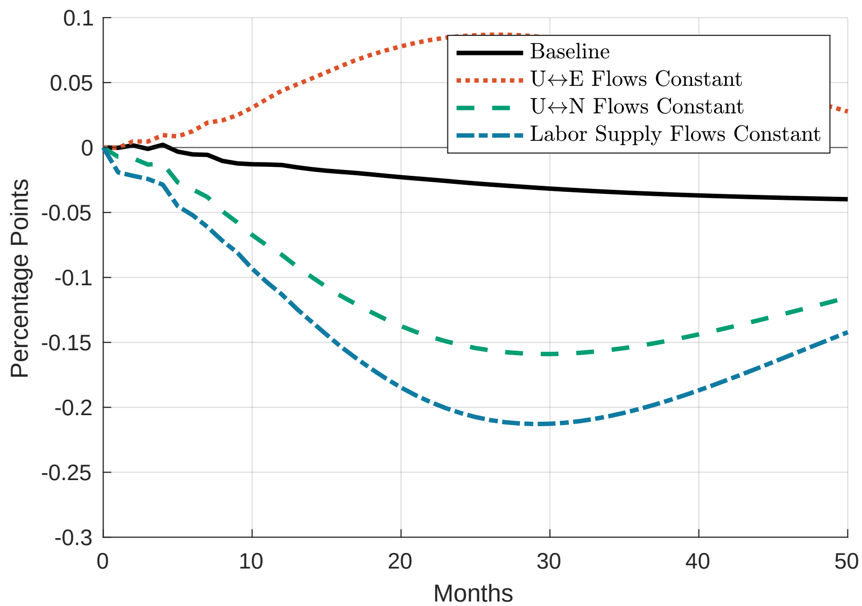
(2015). The additional removal of quits ("Labor Supply Flows Constant") hardly changes the peak unemployment response further.

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↔N flows, as well as a broader labor supply response: U↔N flows + quits to non-employment. The removal of U↔N flows to leads to a peak fall in the employment-population ratio that is almost 60% larger than in the baseline.

Why does removing U↔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↔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↔N flows to either the unconditional or conditional cyclical behavior of employment.

Next, to understand the full importance quantitative importance of labor supply in shaping the response of employment to a a contractionary monetary policy shock, we also consider the response of quits. When we remove U↔N flows + quits the employment-population ratio falls by roughly an additional 40%. Hence, absent the contribution from the response of labor supply flows to a contractionary monetary

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.

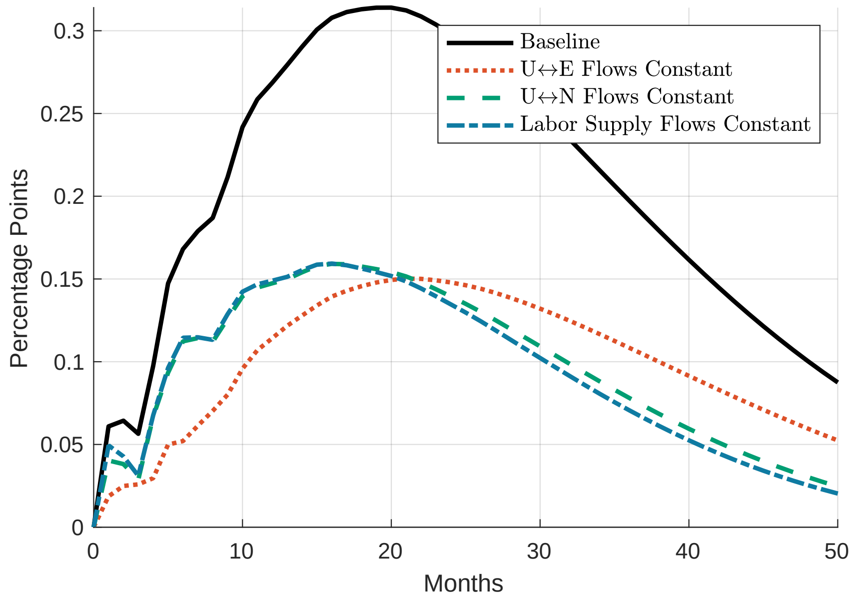
policy surprise, the employment-population ratio nearly doubles.[27] Put differently, the increase in labor supply flows in response to a contractionary monetary policy shocks reduces the decline in employment by nearly half. Such an increase in labor supply can easily be understood through an income effect: faced with a worsening economy and more limited budget sets, households increase their labor supply.[28]

What happens to employment if we allow labor supply flows to respond, but we hold U↔E flows constant? Recall, the response of U↔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↔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.

[27]Note 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.

[28]We offer validatation for this interpretation in the next section, where we consider heterogeneity in the labor supply response of ex-ante distinct subgroups of workers.

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.

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 partication ratio, we study a similar decomposition for the labor force participation ratio in Figure 16. Shutting down U↔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↔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 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.[29]

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

The previous section shows that the labor supply increase to a contractionary monetary policy shock attenuates the overall decline in employment by roughly one half. While the sticky-wage New Keynesian literature typically abstracts from any such role for labor supply (as discussed by Broer et al. 2020), we have discussed that such a response can naturally be understood as being driven by an income effect: in face of a monetary contraction, households “feel poorer” and supply more leisure.

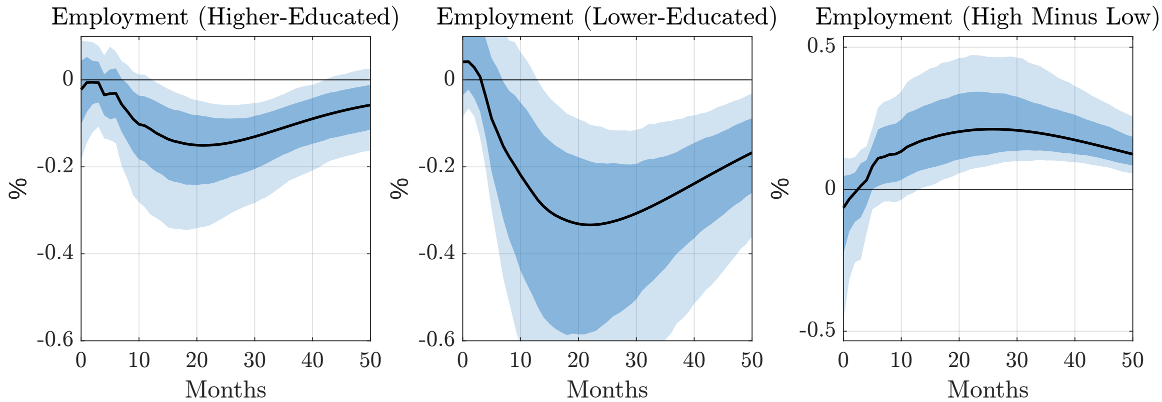
Here, we study the labor supply response of lower– and higher–educated workers.[30] Lower-educated workers typically have fewer financial assets by which to smooth consumption. But moreover, we establish that lower-educated workers face more severe reductions in employment in response to a monetary policy contraction, due in large part to a greater increase in the probability of being laid-off. Thus, under the interpretation that the aggregate increase in labor supply to a monetary policy contraction can be understood through an income effect, we should expect a greater increase in labor supply from lower-educated workers. We show that this is indeed the case: lower-educated workers exhibit a far greater increase in labor supply in the face of a monetary policy contraction, most evident from a decrease in quits to nonparticipation.

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.

[29]Here, 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).

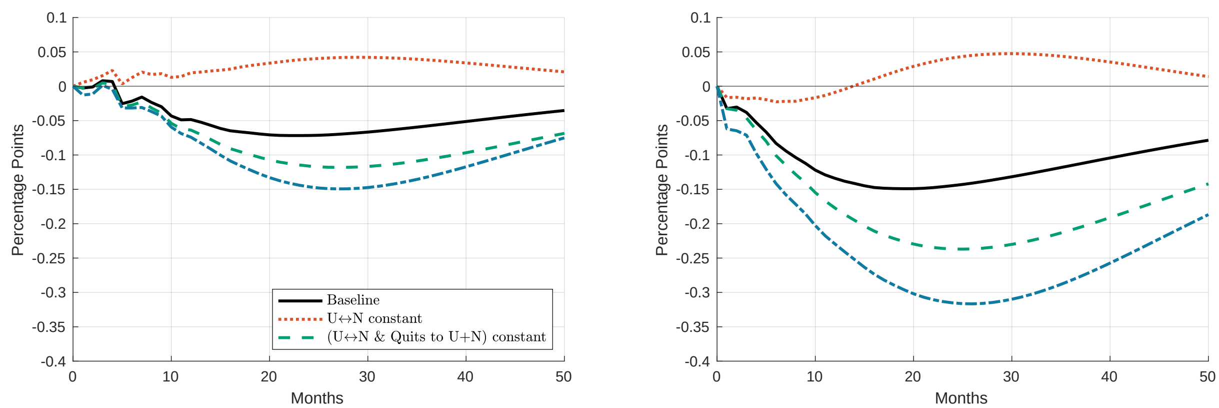
[30]We classify an individual as higher-educated if they have attended at least some college, whereas a worker is designated to be lower-educated if their maximum educational attainment is a high school diploma.

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



(A) Higher-Educated (B) Lower-Educated

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.

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 employment-to-unemployment flows to a monetary contraction are substantially larger for lower-educated workers 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—broadly associated with a decline in quits—is concentrated among lower-educated workers. There is no discernable drop for higher-educated workers. Finally, higher-educated workers show virtually no reduction in flows from nonparticipation to employment after a monetary contraction.[31] The larger increase in employment-to-unemployment flows and reduction in nonparticipation-to-employment flows among low-educated workers is consistent with a greater reduction in labor demand; whereas the larger decrease in quits from employment to nonparticipation is consistent with a larger increase in labor supply.

In Figure 19, we repeat the analysis of Section 4.2 to assess the importance of labor supply flows in shaping the employment response to a contractionary monetary policy shock for lower– and higher-educated workers. Holding all labor supply flows fixed, employment among lower-educated workers falls by an additional 0.15 percentage points from a monetary contraction, compared to an additional 0.08 percentage points among higher-educated workers. Thus, our estimates reveal a greater role of labor supply among lower-educated workers in attenuating the employment decline associated with a monetary policy contraction.

We see three 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. To the extent that this supply response is driven not only by a larger increase in layoffs but also through lower asset holdings, our findings suggest that the wealth distribution helps shape the aggregate labor supply response to a monetary policy shock. Third, the greater labor supply response of workers who hold less wealth and incur more severe employment impacts from a contractionary monetary policy shock is consistent with an income effect. We consider this third point in the next section.

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.[32]

[31]As shown in Figure B.7, these flows are statistically different across the lower– and higher-educated workers.

[32]Our focus on such "indirect effects" of monetary policy are consistent with conclusions regarding the transmission of monetary policy from the heterogeneous agent New Keynesian literature, e.g., Kaplan, Moll and Violante (2018).

As we demonstrate, the model includes both a substitution and an income effect of a contractionary monetary policy shock on participation from nonemployment. By the substitution effect, a reduction in the job-finding rate reduces the return to job search; and thus workers are more likely to move from unemployment to nonparticipation to avoid the utility costs associated with actively searching for a job. However, we document the presence of an offsetting income effect, where an increase in the marginal utility of consumption reduces the consumption-equivalent value of leisure, moving workers from non-participation to unemployment.

For our simple model to be consistent with the data, the income effect must dominate.[33] 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.[34]

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

$$\begin{aligned} rV_0(b) = \max_{s \in \{0,1\}} \Bigg\{ & \frac{b - \psi \cdot \mathbb{I}\{s = 1\}}{\mu} \\ & + \Big(\alpha \cdot s + (1 - \alpha)\Big) \cdot \lambda \cdot [\max\{V_1(b), V_0(b)\} - V_0(b)] \\ & + \chi \cdot \left[\int_{\underline{b}}^{\bar{b}} V_0(b') dF(b') - V_0(b) \right] \Bigg\} \end{aligned} \tag{8}$$

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

---

[33]We also show that the model generates a reduction in quits in response to a higher marginal utility of consumption.

[34]Note, the essential modeling ingredients highlighted here have incorporated into the RBC framework in the pioneering work of Krusell et al. (2017, 2020) and are the subject of further study by Cairó et al. (2022).

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 (8).

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

$$rV_1(b) = \max\left\{rV_0(b), w + \delta\cdot[V_0(b) - V_1(b)] + \chi\left[\int_{\underline{b}}^{\bar{b}} \max\{V_0(b'), V_1(b')\}dF(b') - V_1(b)\right]\right\} \tag{9}$$

The only decision of the employed worker is whether to quit her job.

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 b^s and b^q such that $\underline{b} < b^s < b^q < \bar{b}$. Non-employed workers strictly prefer to search for a job when $b < b^s$, are indifferent between searching and not searching when $b = b^s$, and strictly prefer to not search when $b > b^s$. Non-employed workers strictly prefer accepting a job when $b < b^q$, are indifferent between accepting a job and not accepting a job when $b = b^q$, and strictly prefer to not accept a job when $b > b^q$. Finally, employed workers are indifferent between remaining employed and quitting a job when $b = b^q$, strictly preferring to remain employed when $b < b^q$ and strictly preferring to quit to non-employment when $b > b^q$.

We establish several useful results, beginning with Corollary 1:

Corollary 1 (Active search 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 b^s such that $V_0^s(b^s) = V_0^{ns}(b^s)$ satisfies*

$$\frac{\psi}{\mu} = \alpha\cdot\lambda\cdot(V_1(b^s) - V_0(b^s)) \tag{10}$$

Proof. See Appendix C. □

Equation (10) 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, $\alpha \cdot \lambda \cdot (V_1(b^s) - V_0(b^s))$ reflects the additional capital gains associated with the higher rate of job offers for a worker engaged in active search.

We also establish Corollary 2:

Corollary 2 (Quit threshold)**.** *Define b^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 b^q satisfies*

$$\frac{b^q}{\mu} = w + \chi \int_{\underline{b}}^{b^q} (V_1(b') - V_0(b'))\, dF(b') \tag{11}$$

Proof. See Appendix C. □

Note, the quitting/accepting threshold b^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 b^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.[35]

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 b^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. □

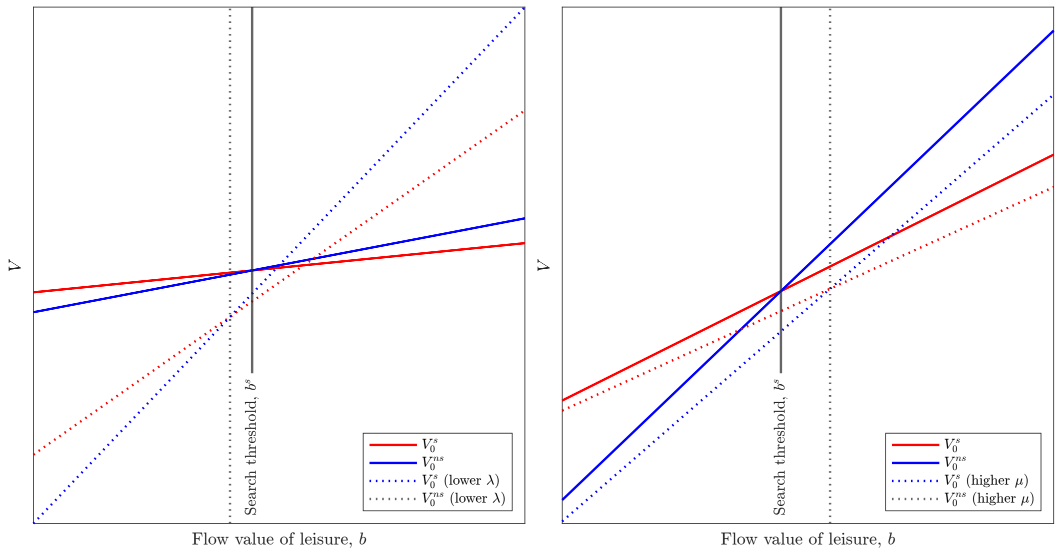
To see the logic of the proof, see from the Appendix that, if $\chi = 0$, equation (10) can be written more simply as

$$\underbrace{\left(\frac{\psi}{\mu}\right)}_{\substack{\text{Cost of active search} \\ \text{(in consumption units)}}} = \alpha \cdot \lambda \underbrace{\left(\frac{w - \frac{b^s - \psi}{\mu}}{r + \delta + \lambda}\right)}_{\substack{\text{Additional capital gains} \\ \text{from active search}}} \tag{12}$$

where the term in parentheses on the right side of equation (12) 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 the left panel of Figure 21, the reduction in λ decreases the rate at which workers find jobs, and thus the relative benefit of search decreases. This represents a pure substitution effect, and so b^s will thereby decrease and fewer workers will search.

[35]We 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.

FIGURE 21. The Substitution and Income Effects of a Monetary Policy Shock



Note: Non-employed with flow value of leisure b less than the threshold b^s engage in active search. In the left panel, a decrease in the aggregate component of job-finding rate λ decreases b^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 increases b^s and thus increases the fraction of workers in non-employment engaged in active 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 $(b^s - \psi)/\mu$ declines, increasing the flow surplus of employment.[36] This represents an income effect, pushing b^s up so that a larger mass of non-employed workers will be engaged in search, as shown in the right panel of Figure 21. In contrast, shocks to μ and λ move the quit threshold weakly in the same direction, as discussed in the Appendix.[37]

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

[36]Note, 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.
[37]Note, for $\chi = 0$, the quit threshold is unaffected by changes in λ.

income effect should not only be present, but also sufficiently strong to offset the counteracting substitution effect.

A recent literature including Nekarda and Ramey (2020) and Auclert et al. (2021) has argued for the inclusion of sticky wages into the standard New Keynesian framework. As discussed by Broer et al. (2020), however, the inclusion of sticky wages into an NK model with a neoclassical labor market clearing condition precludes a role for income effects on labor supply in determining aggregate employment dynamics, contrary to the estimates shown here. Moreover, workers may be required to provide labor against their own will under such a framework, as documented by Huo and Ríos-Rull (2020). In contrast, under a search framework, income effects can be an important ingredient in explaining the response of labor market flows to a monetary policy shock even if wages are held fixed, as shown here. By additionally allowing for endogenous quits and layoffs, such a model maintains the principle of free exchange, avoiding the criticism of Huo and Ríos-Rull (2020).

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".[38] The remaining EU transitions, we label as other separations.[39]

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.[40] We label an EN transition as a quit if the reason for leaving the job is "personal, family or school" or "unsatisfactory work arrangements".[41] 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.[42] 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

[38] Ideally 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.

[39] These are transitions where the reason for unemployment is "re-entrant" or "new entrant". Such transitions account for 15-20% of all EU transitions.

[40] In 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.

[41] These are the possible answers from before 1994. After 1994 we define such transitions analogously.

[42] Other 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.

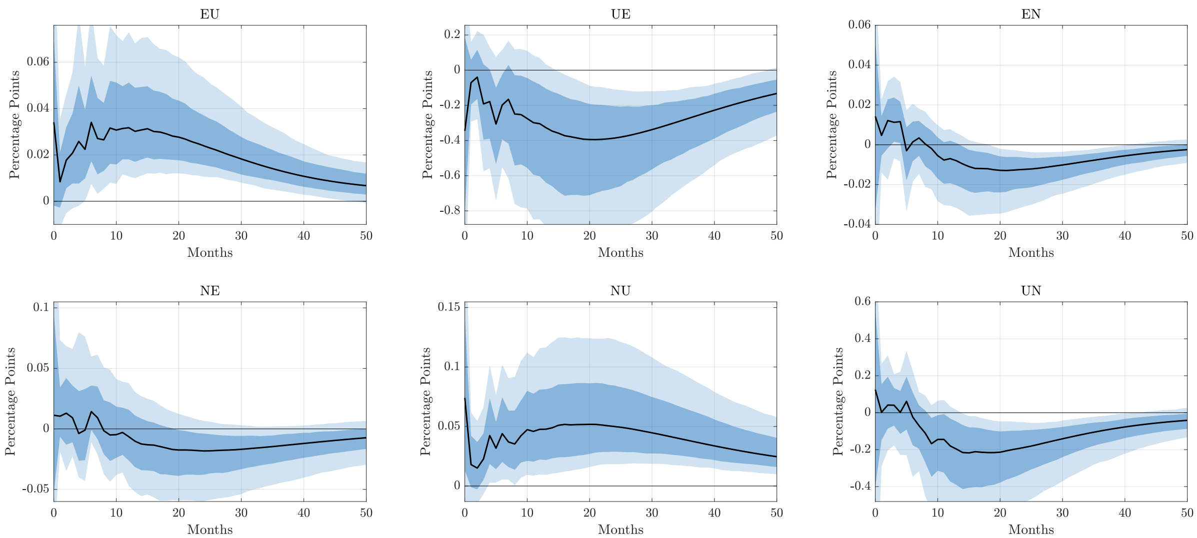
A.2. **"Intensive Margin" of Labor Supply.** Our measure of the intensive margin for unemployed workers is the number of distinct job search methods that they report. The re-design of the CPS in 1994 complicates the construction of a consistent series for this measure, as it increased the number of possible 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.[43]

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.

[43]In 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.

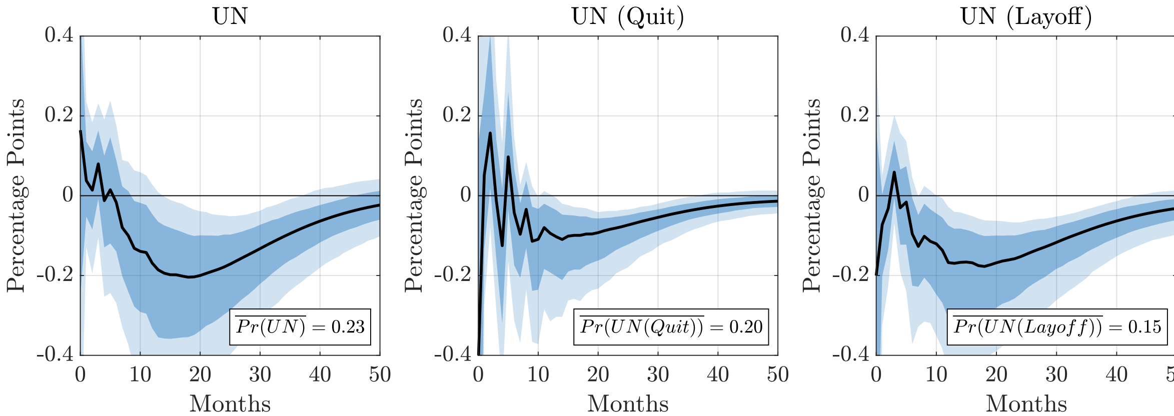
Appendix B. Additional Figures

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



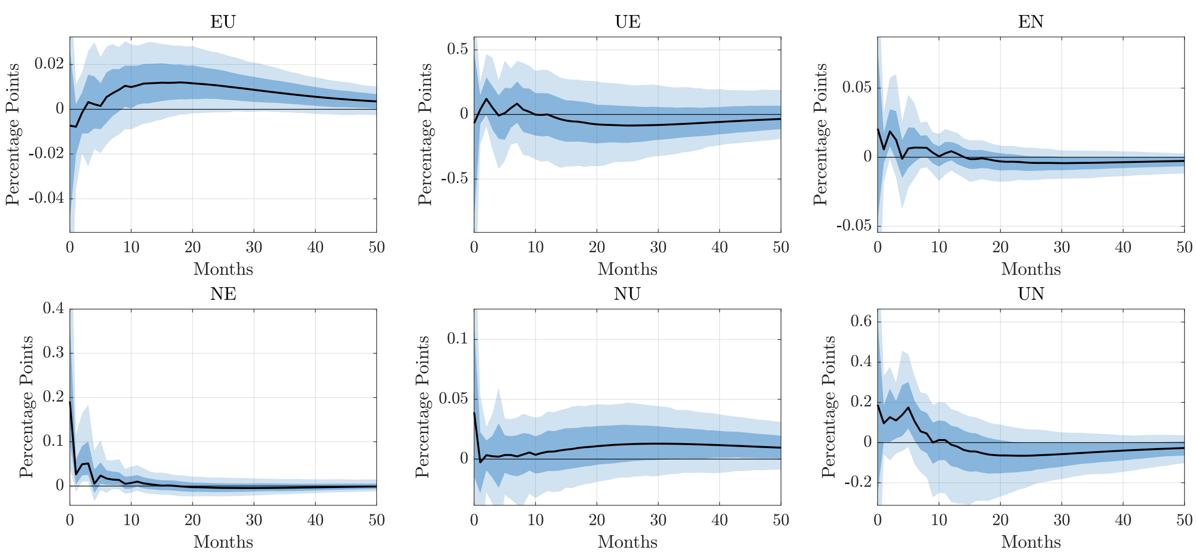
Note: We construct composition-adjusted flow rates holding fixed shares by age, gender and education, as in Table 5 of Elsby, Hobijn and Şahin (2015). The responses of the composition-adjusted IRFs for labor market flows are similar to those from our baseline, in Figure 6. We thus conclude that our baseline 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



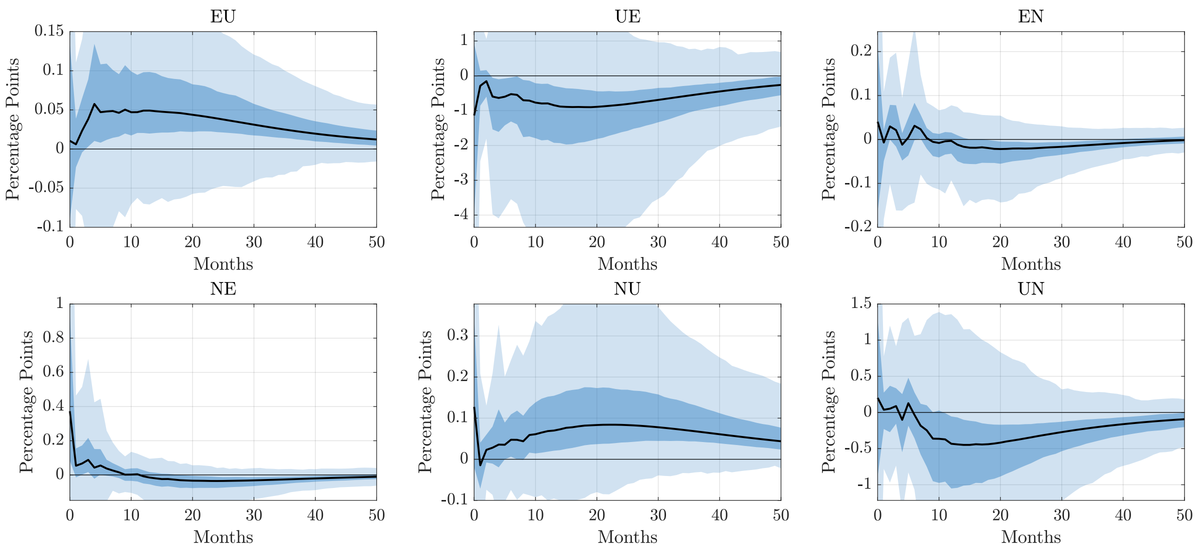
Note: We compute separate IRFs for UN flows by reason for unemployment to verify that the aggregate increase in UN flows is not an artifact of an increasing share of workers in unemployment due to layoff. The IRF for the total UN flow is very similar to that for the subgroup of the unemployed who have 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



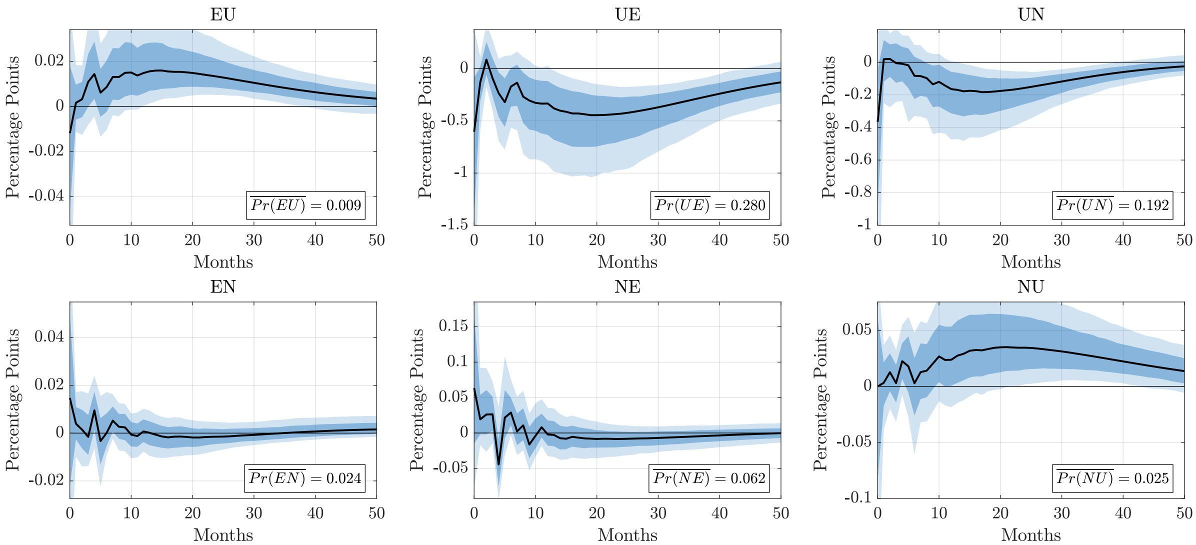
Note: Here, we estimate the response of labor market flows to a monetary policy shock using FOMC announcements that are not orthogonalized as in Bauer and Swanson (2023a,b). Compared to our baseline estimates from Figure 6, the recovered IRFs show a weaker response of labor market flows to a contractionary 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.



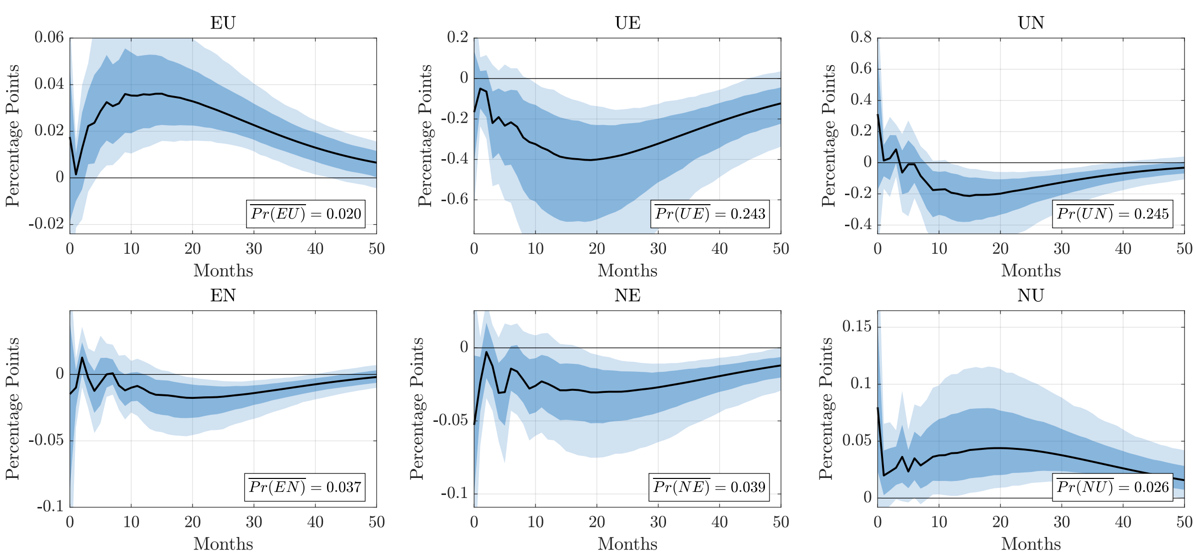
Note: We estimate the response of labor market flows to a monetary policy shock using FOMC announcements that are orthogonalized according to the procedure of Bauer and Swanson (2023a,b). Compared to Figure B.3, the IRFs here are larger in magnitude, indicating the importance of removing predictable 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: Higher-educated



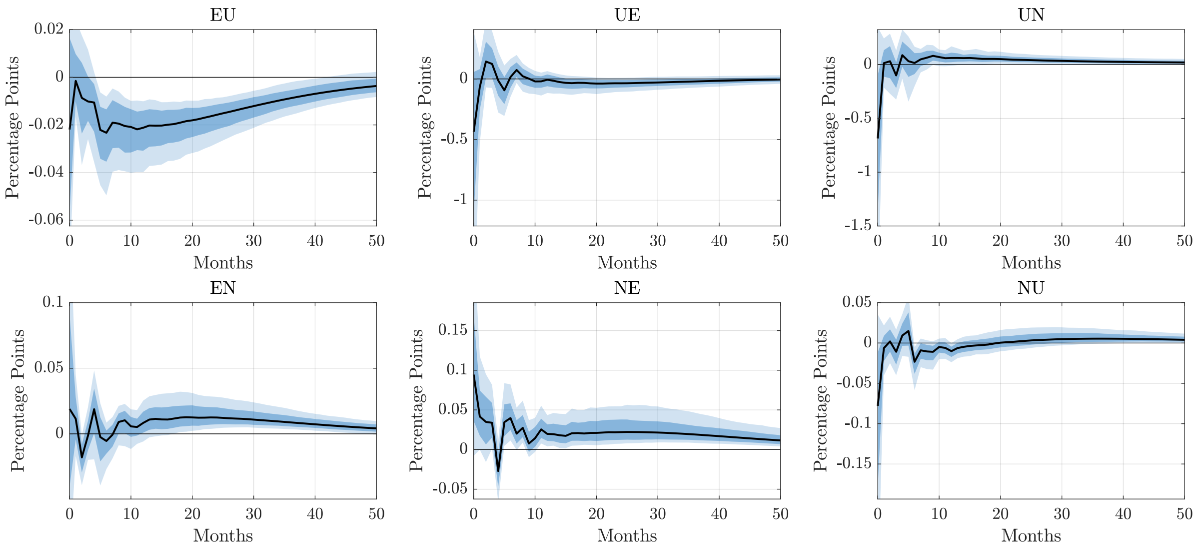
Note: Estimated impulse responses to a 25bp monetary policy tightening shock, computed by appending the given labor market flow variable to the baseline VAR from Figure 5. Solid black lines report impulse response functions while dark and light shaded regions report bootstrapped 68% and 90% confidence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

Figure B.6. Labor Market Flows: Lower-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 dark and light shaded regions report bootstrapped 68% and 90% confidence intervals. See text for details.

FIGURE B.7. Labor Market Flows: Higher-educated minus lower-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 dark and light shaded regions report bootstrapped 68% and 90% confidence intervals. See text for details.

Appendix C. Model Appendix

Using equations (8) and (9) for the values of non-employment and employment, write the worker surplus $V_1(b) - V_0(b)$ as

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

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

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

and

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

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

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

Thus,

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

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 $[\underline{b}, \bar{b}]$, $\exists\, b^q \in (\underline{b}, \bar{b})$ s.t. $V_1(b^q) - V_0^{ns}(b^q) = 0$ and $b^s \in (\underline{b}, \bar{b})$ s.t. $V_0^s(b^s) - V_0^{ns}(b^s) = 0$.[44] Solve for b^s such that $V_0^{ns}(b^s) = V_0^s(b^s)$:

$$\frac{\psi}{\mu} = \alpha \cdot \lambda \left(V_1(b^s) - V_0^s(b^s)\right) \tag{C.5}$$

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

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

Corollaries 1 and 2 follow.

To prove Proposition 1, set $\chi = 0$, substitute equation (C.1) into (C.5), and then simplify to obtain (12). Solving for b^s, we obtain

$$b^s = \mu w - \frac{(\rho + \delta + (1-\alpha)\lambda)\psi}{\alpha\lambda} \tag{C.7}$$

[44] Note, $b^s < b^q$; otherwise, agents would make strictly positive gains from not searching.

Take derivatives with respect to μ and λ:

$$\frac{\partial b^s}{\partial \mu} = w \tag{C.8}$$

$$\frac{\partial b^s}{\partial \lambda} = \frac{(\rho + \delta)\psi}{\alpha \lambda^2} \tag{C.9}$$

Both $\partial b^s / \partial \mu$ and $\partial b^s / \partial \lambda$ are strictly positive.

Recall, non-employed workers with $b \in [\underline{b}, b^s]$ 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 (11) at $\chi = 0$, an increase in the marginal utility of consumption will increase the quit threshold b^q, thereby reducing the mass of employed workers in $[b^q, \bar{b}]$ who will optimally quit from their job; whereas b^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 $b \in [\underline{b}, b^q]$. Thus, if $\chi > 0$, b^q will be increasing in λ through second term on the right side of (11) reflecting the option value of employment. This is seen in Figure 21, where we do not restrict χ to be equal to zero.