

FEDERAL RESERVE BANK OF KANSAS CITY

ECONOMIC REVIEW

Fourth Quarter 2023

Volume 108, Number 4

Do Immigration Restrictions Affect Job Vacancies? 5
Evidence from Online Job Postings
By Elicor Cohen and Samantha Shampine

Capital Flows and Monetary Policy in Emerging 35
Markets around Fed Tightening Cycles
*By Johannes Matschke, Alice von Ende-Becker,
and Sai A. Sattiraju*

Do the Effects of Interest Rate Changes Depend 49
on Inflation?
By Dimitris Christopoulos, Peter McAdam, and Elias Tzavalis

Do Immigration Restrictions Affect Job Vacancies? Evidence from Online Job Postings

By Elior Cohen and Samantha Shampine

The U.S. workforce relies heavily on immigration. However, a series of policy changes and the COVID-19 pandemic led to a rare decline in immigrant arrivals from 2016 to 2021. This period of reduced immigration coincided with and exacerbated already severe shortages in the U.S. labor market, leading employers and firms to look for new sources of labor. At the same time, online job postings became more prevalent as a method of searching for labor. These postings provide rich data that could help reveal how different dimensions of labor demand change in response to declining immigration.

Elior Cohen and Samantha Shampine examine how declining immigration flows influence online job vacancies in labor markets with different levels of reliance on immigrant labor. They find that the growth rate of online job postings increased modestly in labor markets that historically relied more heavily on immigrant labor. In addition, they find that the content of those postings changed substantially as immigration declined: in more immigrant-reliant labor markets, starting wages increased and skill requirements grew more slowly. Their results highlight that as fewer immigrants arrive, firms in more immigrant-reliant labor markets disproportionately increase their job search efforts.

Capital Flows and Monetary Policy in Emerging Markets around Fed Tightening Cycles

By Johannes Matschke, Alice von Ende-Becker, and Sai A. Sattiraju

The Federal Reserve's interest rate hikes in 2022–23 raised concerns about spillover effects on smaller emerging market and developing economies. Historically, a higher U.S. federal funds rate has been associated with international investors withdrawing capital from emerging markets, which can lead to lower economic activity and depreciating exchange rates in these markets—and, in turn, greater financial vulnerability. To reduce capital outflows, central banks in emerging markets can tighten their own monetary policy rates to increase yields on debt securities. But raising interest rates comes with trade-offs, and how central banks in emerging markets respond to tighter U.S. monetary policy remains an empirical question.

Johannes Matschke, Alice von Ende-Becker, and Sai A. Sattiraju examine the three most recent U.S. policy tightening cycles to analyze when and why central banks in emerging markets raised their own policy rates. They find that while emerging markets sometimes raised rates in response to capital outflows or a depreciation of their currency resulting from U.S. monetary policy, they more frequently raised rates in response to domestic inflationary pressures. Their findings provide new descriptive evidence on the conduct of monetary policy in emerging markets.

Do the Effects of Interest Rate Changes Depend on Inflation?

By Dimitris Christopoulos, Peter McAdam, and Elias Tzavalis

Inflation, as measured by the 12-month change in the consumer price index, fell from a peak of 9 percent in June 2022 to 3.7 percent in August 2023. Despite this decline, inflation remains well above the Federal Open Market Committee's longer-run objective of 2 percent. In recent decades (starting in the mid-1990s), inflation generally averaged below 2 percent, contrasting with periods of high inflation in the 1970s and 1980s. Accordingly, many economists have interpreted inflation rates over time as being persistently "high" or "low." These regimes may influence how monetary policy affects the economy.

Dimitris Christopoulos, Peter McAdam, and Elias Tzavalis assess whether U.S. monetary policy (represented by the path of the federal funds rate) has different effects on the economy depending on which inflation state the economy is in. They find that the economy reacts more slowly and with more volatility to a change in monetary policy in a high-inflation state than in a low-inflation state. They also find that in a high-inflation state, interest rates must be held higher for longer to bring inflation back down relative to a low-inflation state.

Do Immigration Restrictions Affect Job Vacancies? Evidence from Online Job Postings

By Elior Cohen and Samantha Shampine

The U.S. workforce relies heavily on immigration, with one out of every six workers originating from outside the country's borders in 2021. However, the supply of new immigrant labor has varied widely over the past decade. Although an average of 1 million immigrants entered the country annually from 2000 to 2016, a series of policy changes and the COVID-19 pandemic led to a rare decline in immigrant arrivals from 2016 to 2021. This period of reduced immigration coincided with and exacerbated already severe labor shortages in the U.S. labor market, leading employers and firms to look for new sources of labor.

In recent years, online job postings have become more prevalent as a method of searching for labor. In addition to providing information on the overall demand for labor in the economy, online postings contain rich data on a job's characteristics, location, industry, offered wages, and skill requirements. These data could help reveal how different dimensions of labor demand change in response to declining immigration. However, little is known about the link between immigration and online job postings.

In this article, we examine how declining immigration flows influence online job vacancies in labor markets with different levels of reliance on immigrant labor. We find that the growth rate of online job postings

Elior Cohen is an economist at the Federal Reserve Bank of Kansas City. Samantha Shampine is a former research associate at the bank. This article is on the bank's website at www.KansasCityFed.org

increased modestly in labor markets that historically relied more heavily on immigrant labor, but the content of those postings differed substantially: in more immigrant-reliant labor markets, starting wages increased and skill requirements grew more slowly as immigration declined. Our results highlight that as fewer immigrants arrive, firms in more immigrant-reliant labor markets increase their job search efforts (as measured by both the number and content of their online job postings).

Section I describes how and why the trend in U.S. immigration flows reversed from increasing to decreasing in 2016. Section II describes the uneven distribution of immigrant workers in the U.S. economy and shows how the 2016 trend reversal in immigration had differential labor supply effects based on a sector's degree of reliance on immigrant labor. Section III examines online job postings and shows that labor search intensity increased in more immigrant-reliant sectors in response to the 2016 trend reversal in immigration.

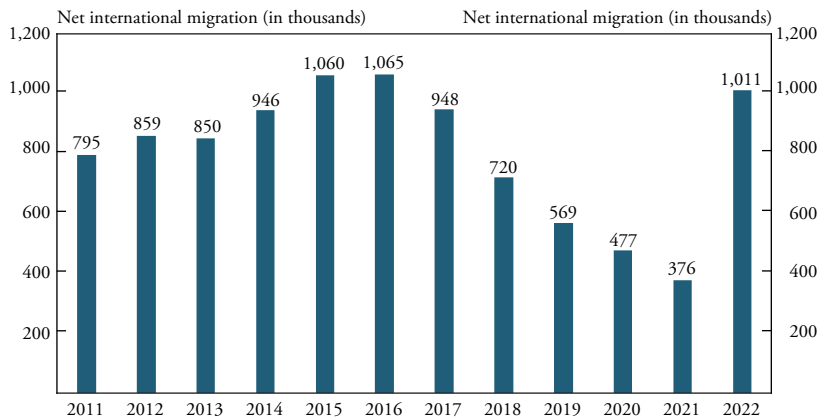
I. Immigration and the U.S. Labor Market

Immigration to the United States shifted from an increasing trend from 2011 to 2016 to decreasing from 2017 to 2021, due to a series of immigration policy changes and travel restrictions related to the COVID-19 pandemic. Chart 1 shows annual net international migration to the United States—that is, the number of incoming immigrants minus the number of outgoing emigrants—from 2011 through 2022. From 2011 to 2016, net international migration was on an increasing trend, reaching more than 1 million immigrants per year in 2015 and 2016. From 2017 to 2021, this trend reversed: immigration gradually declined until reaching a low of 376,000 in 2021. In 2022, both immigration policy and pandemic-related travel restrictions eased. Accordingly, immigration has since rebounded close to its 2016 level and is expected to return to its pre-2016 trend. Thus, the 2016–21 period may provide a useful and rarely observed test case for the effect of declines in immigration on labor markets, particularly at times when labor markets are tight.

Immigration policy changes and the onset of the COVID-19 pandemic largely drove the observed shift in immigration flows. Starting in late 2016, hundreds of executive actions were passed to increase immigration enforcement, temporarily freeze refugee admissions, and restrict

Chart 1

Net International Immigration to the United States Declined from 2016 to 2021



Note: Chart shows net international migration to the United States (incoming immigrants minus individuals who left the United States) for each year from 2011 to 2022.
Source: U.S. Census Bureau.

family immigration through the Reforming American Immigration for Strong Employment (RAISE) Act, directly restricting immigration to the United States (U.S. Department of Homeland Security 2022). Immigration declined further with the onset of the COVID-19 pandemic as border closures used to mitigate the spread of COVID-19 reduced immigration flows to their lowest levels in decades. In particular, a new policy tool that limited international travel to the United States during the pandemic, Title 42, made it easier for border officers to prevent potential migrants from entering the United States (U.S. Customs and Border Protection 2023).

The post-2016 decline in immigration flows occurred at a time of increased demand for labor and widespread labor shortages, exacerbating the mismatch between labor supply and demand.¹ Unfilled job vacancies increased from an average of 5.8 million in 2016 to 7.2 million by 2019 and spiked to almost 10 million by the end of 2021. The job openings rate, measured as the number of new unfilled jobs as a percentage of employment and job openings, increased by more than 70 percent from 2016 to 2021. Over the same period, the number of unemployed individuals in the labor market reached historically low levels. As a result, the ratio of vacancies to unemployed individuals—a

standard measure of labor market tightness—reached over two unfilled vacancies for every unemployed individual in 2021 and has remained elevated, indicating a labor market in which jobs are plentiful and workers are scarce.

II. Differential Reliance on Immigrant Workers across Labor Markets

The post-2016 decline in immigration did not have identical effects across the U.S. economy. Immigrant labor is unevenly distributed across geographies, industries, and occupations, suggesting certain labor markets would be hit more heavily than others. Table 1 summarizes the variation in foreign-born workers across states, industries, and occupations. Industries are defined using three-digit codes from the North American Industry Classification System (NAICS), while occupations are defined using three-digit codes from the Standard Occupational Classification (SOC) system. Specifically, Table 1 presents the mean percentage of foreign-born workers—along with the minimum, 25th percentile, 50th percentile (median), 75th percentile, and maximum percentage of foreign-born workers—across states, industries, and occupations in 2021. Although almost one out of three workers in California were foreign-born in 2021 (30.2 percent), only 1.3 percent of all workers in West Virginia were immigrants. Some industries, such as knitting fabric mills and clothing stores, have a high percentage of foreign-born workers, while others, such as utilities and health and personal care stores, have a lower percentage of foreign workers. Immigrants also sort into occupations, with one in three textile workers being foreign-born compared with only 3 percent of firefighters. Appendix A provides comprehensive lists of the foreign-born shares by state, industry, and occupation in 2010 and 2021.

The uneven distribution of immigrant labor makes measuring the effect of immigration on labor market outcomes challenging (Blau and Mackie 2016). Immigrants may target locations, industries, and occupations based on labor market conditions such as job opportunities and wages. A common approach that attempts to overcome these nonrandom choices of immigrants relies on the historical persistence of immigration (Card 2001). New immigrants tend to settle in areas and sort into industries and occupations that previous immigrants have

Table 1
Foreign-Born Employment Shares Vary across States, Industries, and Occupations

Category	Category size	Mean (percent)	Minimum (percent)	25th percentile (percent)	50th percentile (percent)	75th percentile (percent)	Maximum (percent)
State	51	10.3	1.3 West Virginia	5.2 Tennessee	8.0 North Carolina	15.3 Washington	30.2 California
Industry (three-digit NAICS)	97	14.3	0.2 Utilities	10.9 Communications	12.5 Health and personal care stores	16.4 Clothing stores	55.1 Knitting fabric mills
Occupation (three-digit SOC)	98	12.4	3.0 Firefighters	8.8 Entertainers and performers	11.3 Drafters, engineering technicians	14.8 Financial specialists	32.4 Textile workers

Note: Table demonstrates how immigrant labor is unevenly distributed across states, industries, and occupations by reporting the 2021 percentage of foreign-born workers out of all workers in each of the three categories.
Source: U.S. Census Bureau.

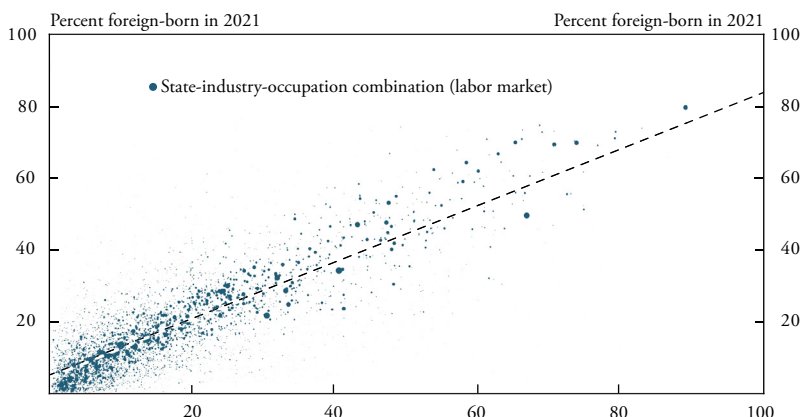
settled and sorted into. To demonstrate this, we use data from the American Community Survey (ACS), which includes a respondent’s immigration status, state of residence, occupation, and industry. Then, we define each labor market as a state-occupation-industry combination.²

Chart 2 plots the percentage of foreign-born workers in each labor market as a share of its total labor force in 2021 on the vertical axis and its respective 2010 percentage on the horizontal axis. The black dashed line presents a linear fit of the two variables. The scatterplot and its fitted line show a clear and robust positive relationship between the past and current percentage of foreign-born workers in each labor market. The fact that foreign-born rates in labor markets remain similar over time, even as the population and economic conditions change, suggests that new immigrants sort into specific locations, industries, and occupations in a relatively stable and persistent way over time. (Appendix A further demonstrates this persistence by presenting comprehensive lists of the 2010 and 2021 foreign-born shares by state, industry, and occupation.)

The significant variation in immigrant labor and its persistence over time can be combined to create a measure of how reliant states, industries, and occupations are on immigrant labor that is more likely to be independent of current economic conditions. Therefore, we measure a labor market’s reliance on immigration using its 2010

Chart 2

New Immigrants Sort into Labor Markets Based on Historical Trends



Notes: Each blue dot in the chart represents one labor market (that is, one state-industry-occupation combination) out of 14,863 overall that appear in the ACS in each year from 2010 to 2021. Dot size is proportional to the number of observations in each combination. The horizontal axis shows the percentage of foreign-born workers in the state-industry-occupation combination in 2010, while the vertical axis shows the respective percentage in 2021. The dashed black line is the fitted linear regression line for the two variables.

Source: U.S. Census Bureau.

percentage of foreign-born workers.³ We then divide labor markets into four groups based on their relative reliance on immigrant workers: very high, high, medium, and low. Using data from the ACS, we construct the distribution of the percentage of foreign-born workers for 14,863 labor markets in 2010. We then use the 90th, 75th, and 50th percentiles as cutoffs for being included in the very high, high, medium, and low reliance groups, respectively.

Table 2 shows each reliance group's cutoff and mean values and provides examples of a labor market in each. For example, agricultural workers in California are in the very high reliance group (90 percent), staff in nursing care facilities in Arizona are in the high group (21 percent), truck drivers in Colorado are in the medium group (13 percent), and public school teachers in Pennsylvania are in the low group (3 percent). We then follow the evolution of different outcomes for these groups over time.⁴

We begin our analysis by examining what happened to the foreign workforce in different labor markets as immigration flows started to decline post-2016. Chart 3 shows the evolution of the log of the immigrant workforce for each of the four reliance groups. We use the log

Table 2
Categories of Reliance on Immigrant Workers

Reliance category	Minimum (percent)	Maximum (percent)	Mean (percent)	Percent of labor force	Example
Very high	30	100	40	18	Agricultural workers (crops) in CA (90 percent)
High	18	30	23	21	Caretakers in nursing care facilities in AZ (21 percent)
Medium	9	18	13	26	Truck drivers in CO (13 percent)
Low	0	9	4	35	Public school teachers in PA (3 percent)

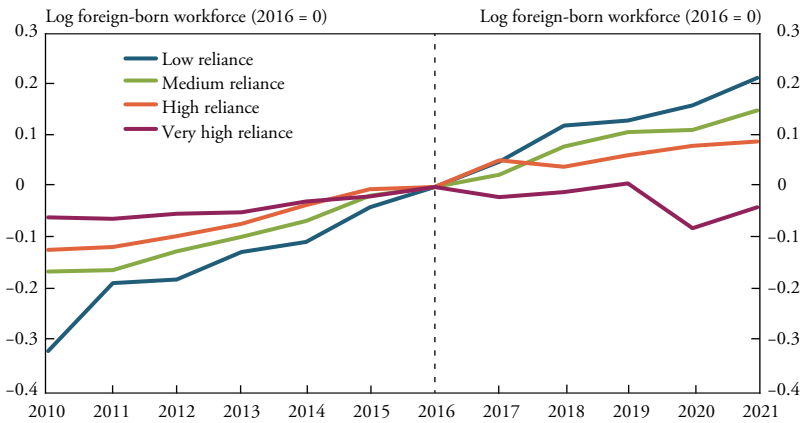
Notes: Table presents the cutoff values for inclusion and relative employment in each of four groups divided by their reliance on immigrant labor. Cutoffs are based on the 2010 percent of foreign-born workers in a state-industry-occupation combination.
Source: U.S. Census Bureau.

of the number of workers because it approximates percent changes, and we standardize all the series to equal 0 in 2016 for ease of interpretation. From 2010 to 2016, the foreign workforce grew across all four reliance groups due to increasing immigration flows. Post-2016, however, growth slowed more in groups with a higher reliance on immigration, especially for the very high reliance group. By the end of 2021, the size of the foreign-born workforce in the very high reliance group was about 5 percent lower than its 2016 level. The three other reliance groups still managed to increase their foreign workforce size post-2016 despite the reduction in immigration flows.⁵ However, the increase was smallest for the high group (around 10 percent), followed by the medium group (15 percent) and the low group (more than 20 percent).

The slowdown in foreign workforce growth coincided with a slowdown in overall employment growth. Overall workforce growth slowed in labor markets with a very high reliance on immigrant labor and did not change in labor markets with a lower reliance. Chart 4 shows the evolution of the log of the overall workforce for each of the four reliance groups. Until 2016, overall workforce growth was similar across all four reliance groups.⁶ Workforce size continued to grow at a similar pace for the low, medium, and high reliance groups, which had a 6 to 8 percent larger workforce size in 2021 relative to 2016. The same was not true for the very high reliance groups. First, the growth rate of the workforce dropped from an average of 1.6 percent per year in 2010–16 to 0.8 percent per year in 2017–19. The COVID-19 pandemic turned

Chart 3

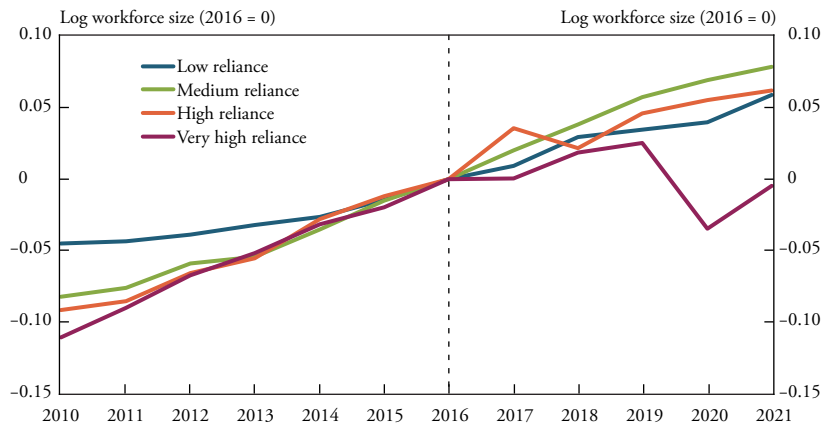
Immigrant Workforce Declines with Reliance Post-2016



Notes: Chart shows the evolution of the log average number of foreign-born workers in each of the four immigrant labor reliance groups in each year from 2010 to 2021. The values are standardized to equal 0 in 2016. Source: U.S. Census Bureau.

Chart 4

Overall Workforce Declines for the Very High Reliance Group



Notes: Chart shows the evolution of the log average number of foreign-born workers in each of the four immigrant labor reliance groups in each year from 2010 to 2021. The values are standardized to equal 0 in 2016. Source: U.S. Census Bureau.

the slowdown to a decline in workforce size in 2020, which, despite a recovery in 2021, remains about 1 percent lower than its 2016 level.

III. Measuring the Effect of the Post-2016 Decline in Immigration on Online Job Postings

Our findings from the previous section suggest that some labor markets experienced a slowdown in labor growth after the 2016–21 decline in immigration, while others did not. These findings are consistent with Borjas (2003), who shows that immigration has a direct short-term labor market effect on a narrow group of workers and industries based on skills and experience. To assess whether employers and firms in these labor markets adjusted their search efforts for workers in response to the decline in immigration, we analyze changes to both the volume and content of online job postings.

The prevalence and popularity of using online job postings as a hiring tool has skyrocketed in the past decade, with the number of online job postings increasing from 12 million in 2010 to more than 53 million in 2022. The share of online job postings out of overall job vacancies also increased from 35 percent to 40 percent during this time. Trends in online job postings are highly correlated with the traditional job openings rate from the Bureau of Labor Statistics' Job Openings and Labor Turnover Survey (JOLTS), suggesting they can proxy for trends in labor demand.

Analyzing labor demand responses using online job postings rather than traditional measures such as JOLTS has three main advantages. First, online job postings contain detailed information on location, industry, and occupation, allowing for a granular observation of labor demand trends. Second, online job postings often include information on a job's wage or salary range, which can reveal how labor input costs change across time, regions, industries, and occupations. Third, online job postings also include information on the experience, education, and skills required for a position, allowing the observation of additional dimensions of labor demand that are rarely observed in practice on a large scale.

Few studies have explored what happens to online job postings as immigration changes, though some researchers find more generally that increased immigration reduces labor search efforts. For example,

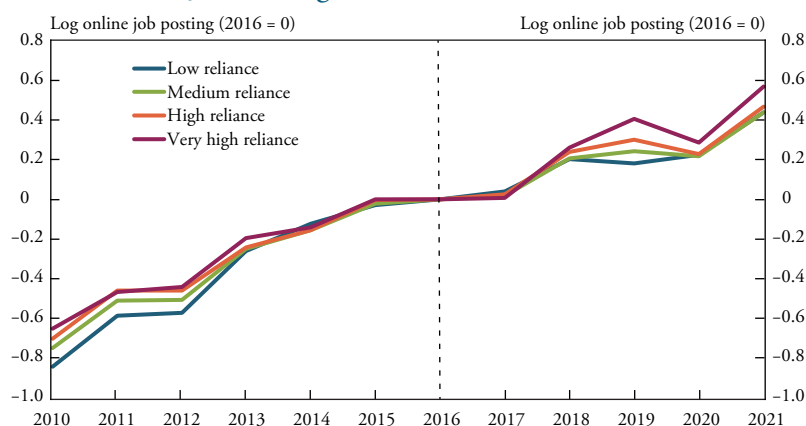
Anastasopoulos and others (2021) study the effect of the Mariel Boatlift—a mass immigration event in the 1980s that led to an 8 percent increase in Miami’s labor supply—on a job vacancies activity index based on newspaper ads. Their findings suggest a nearly 50 percent decrease in Miami’s job vacancies index relative to comparable cities in the first few years after the Mariel shock, followed by a recovery. Another study by Pholpirul (2013) finds that immigration reduced short-term job vacancies in Thai manufacturing. Closer to our context, Duzhak (2023) finds that the slowdown in immigration to the United States after 2016 led to tighter labor markets as measured by the national vacancies-to-unemployment ratio. However, none of these studies presents evidence on changes to the quantity and content of online job postings specifically.

We use online job posting data collected and provided by Lightcast to examine how firms in different labor markets responded to the 2016–21 decline in immigration. These data aggregate job postings from more than 45,000 online job boards and company websites, resulting in a near complete coverage of all jobs posted online. We begin by counting the number of online job postings in each year from 2010 through 2021 for each of the 14,863 labor markets (state-industry-occupation combinations) analyzed in the previous section. We then aggregate the data further based on the four immigrant reliance groups. This exercise allows us to contrast the evolution of online job postings for labor markets based on their dependence on immigrant labor.

We begin our exploration of job postings by showing that the quantity of online job postings evolved similarly across labor markets regardless of their reliance on immigrant labor. Chart 5 contrasts the evolution of the log of online job postings for each of the four reliance groups (standardized to 0 in 2016). Growth in online job postings was relatively similar across all four reliance groups from 2010 to 2016. Although growth was relatively similar for these groups post-2016 as well, it accelerated slightly for labor markets with very high reliance on immigrant labor. For example, while online job postings for the high, medium, and low reliance groups increased by 20 percent on average from 2016 to 2019, they increased by 40 percent on average in the very high reliance group. In 2021, growth in online job postings accelerated across all reliance groups due to the COVID-19 pandemic and the labor shortages that accompanied it. In sum, we find a modest acceleration in online

Chart 5

Overall Online Job Postings Growth Increased with Reliance



Notes: Chart shows the evolution of the log average number of online job postings in each of the four immigrant labor reliance groups in each year from 2010 to 2021. The values are standardized to equal 0 in 2016.

Sources: Lightcast and U.S. Census Bureau.

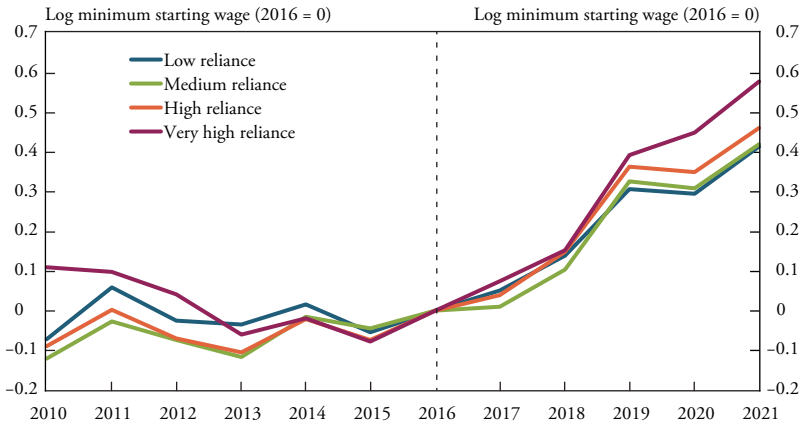
job postings for the highest reliance group, but no meaningful change across the other three groups.

We next examine whether the *content* of online job postings—specifically, the wages and skill requirements—differed in labor markets more or less reliant on immigrant labor. Chart 6 shows the evolution of the log average minimum starting wage listed in an online job posting for each of the four reliance groups. Wage growth in online job postings was stable across the four groups before 2016 and then began to increase and diverge. In particular, the very high reliance group experienced considerably higher wage growth, especially after 2019. The chart suggests that posted wages increased by approximately 60 percent from 2016 to 2021 for the very high reliance group, by 45 percent for the high reliance group, and by around 40 percent in both the medium and low reliance groups.

Chart 7 shows the evolution of the log average number of skills listed in a job posting for each of the four reliance groups.⁷ The skill requirements follow an increasing trend across all reliance categories, suggesting that, on average, the number of skill requirements in a job posting has increased over time. However, the growth rate slowed significantly after 2016, especially among labor markets more reliant on immigrant labor. From 2010 to 2016, the overall number of skills

Chart 6

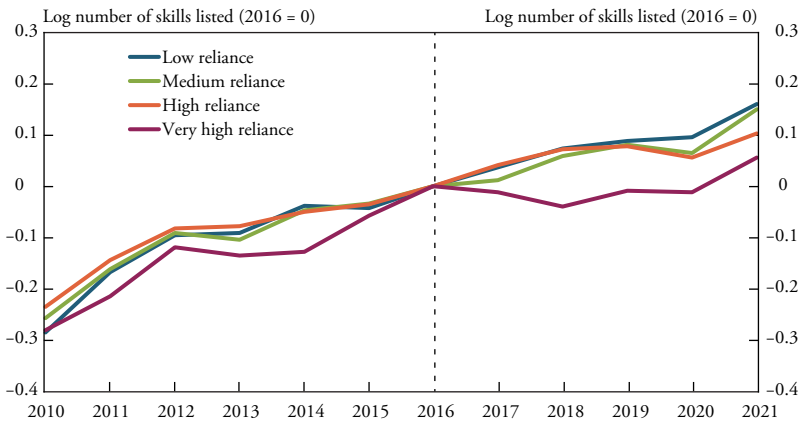
Starting Wages in Online Job Postings Increased with Reliance



Notes: Chart shows the evolution of the log average minimum starting wages in online job postings in each of the four immigrant labor reliance groups in each year from 2010 to 2021. The values are standardized to equal 0 in 2016. Sources: Lightcast and U.S. Census Bureau.

Chart 7

Growth in the Number of Skills in an Online Job Posting Slowed with Reliance



Notes: Chart shows the evolution of the log average number of skills listed in online job postings in each of the four immigrant labor reliance groups in each year from 2010 to 2021. The values are standardized to equal 0 in 2016. Sources: Lightcast and U.S. Census Bureau.

required in a job posting grew by about 23 percent. However, post-2016, the number of skills required increased by slightly more than 5 percent for the very high reliance group and by more than 10 percent for the other three reliance groups. In other words, even though the overall trend suggests an increase in skill requirements over time, the 2016–21 decline in immigration slowed this trend, especially for labor markets more reliant on immigrant workers.

In sum, our findings show that reduced immigration between 2016 and 2021 had modest effects on the growth rate of online job postings across labor markets. However, the content of those postings shifted more substantially: in labor markets that historically relied more heavily on foreign-born workers, starting wages increased and skill requirements growth slowed as immigration declined.

Conclusions

The decline in immigration from 2016 to 2021 provides a rare case study for understanding how firms react and adjust their online labor search in response to changes in immigration flows. We use the 2016–21 decline to study the relationship between immigration and online job postings, which contain detailed information on industry, location, and occupation. We find that the decline in immigration reduced labor supply growth in labor markets that historically have relied heavily on immigrant labor, while not significantly affecting labor markets with less historical reliance on immigrant labor. In addition, we find that employers in labor markets where labor supply growth slowed responded only modestly by increasing the quantity of job postings and more substantially by changing their content—specifically, by increasing starting wages and reducing skill requirements—to attract workers from different labor pools.

Although our analysis focuses on the decline in immigration from 2016 to 2021, it may also shed light on the rebound in immigration in 2022 and its evolution in the coming years. The historical sorting of immigrants to specific labor markets implies that the declines observed in workforce size in labor markets that rely heavily on immigrants will ease; indeed, these declines may even reverse, returning workforce size to or above pre-pandemic levels as new immigrants continue to flow to United States. As labor supply increases in more immigrant-reliant

labor markets, online job postings may decline. As a result, wage growth may be less substantial and persistent in more immigrant-reliant labor markets. However, posted wages are likely to remain stable: once wages increase, it is uncommon for them to go down. In other words, if the recent rebound in immigration continues, employers might react in the opposite way than they reacted in 2016–21—that is, they may reduce the number of job postings, increase the number of skill requirements in postings, and slow growth in starting wages.

Our findings contribute to understanding how labor markets operate in response to declines in immigration flows. Our findings suggest that changing immigration flows would have uneven effects on the U.S. economy, with some regions, industries, and occupations likely to have a more significant effect in terms of reduced labor supply and increased labor search costs that result from it. While we find an increase in posted wages as immigration declines, we do not see a similar increase in employment in labor markets that rely on immigrant labor. This finding suggests that some jobs filled by immigrants are not easy to fill using native-born workers or to substitute with technology.

Appendix A

State, Industry, and Occupation Foreign-Born Shares

The tables in this section provide detail on the variation in presence of foreign workers across states, industries, and occupations using data from the 2010 and 2021 American Community Survey (ACS). Each list shows the percentages of foreign-born workers in the state, industry, or occupation workforce in 2010 and 2021. We define industry as a three-digit NAICS code and occupation as a three-digit SOC code. The tables demonstrate the large variation and the persistence of immigrant labor.

Table A-1

State Foreign-Born Share in Labor Force

State	2010 (percent)	2021 (percent)
Alabama	4.2	3.7
Alaska	6.0	11.9
Arizona	15.2	14.9
Arkansas	3.9	4.7
California	34.3	32.0
Colorado	11.0	11.1
Connecticut	15.7	19.2
Delaware	9.5	14.5
District of Columbia	15.5	15.3
Florida	22.6	25.6
Georgia	11.8	12.8
Hawaii	22.9	22.1
Idaho	6.6	9.1
Illinois	17.6	18.0
Indiana	6.3	7.8
Iowa	5.8	6.7
Kansas	7.6	9.1
Kentucky	4.2	5.1
Louisiana	4.9	4.4
Maine	4.5	4.6
Maryland	18.1	20.0
Massachusetts	17.9	20.9
Michigan	7.5	8.9
Minnesota	8.8	12.7
Mississippi	2.4	2.4
Missouri	5.4	5.9

Table A-1 (continued)

State	2010 (percent)	2021 (percent)
Montana	2.1	3.2
Nebraska	7.0	8.6
Nevada	22.8	21.7
New Hampshire	6.7	8.3
New Jersey	26.0	28.4
New Mexico	9.6	12.2
New York	27.1	27.3
North Carolina	9.1	10.3
North Dakota	3.3	9.9
Ohio	5.3	7.0
Oklahoma	5.1	6.8
Oregon	13.1	12.5
Pennsylvania	7.4	9.5
Rhode Island	11.9	16.7
South Carolina	5.8	6.2
South Dakota	2.2	6.0
Tennessee	5.9	6.1
Texas	18.1	20.2
Utah	10.5	9.5
Vermont	4.5	7.2
Virginia	14.2	14.8
Washington	17.0	20.1
West Virginia	1.9	2.6
Wisconsin	5.8	7.1
Wyoming	4.0	2.2

Source: U.S. Census Bureau.

Table A-2
Foreign-Born Share in Occupation

Occupation (sorted by three-digit SOC code)	2010 (percent)	2021 (percent)
Top executives	12.3	15.2
Advertising, marketing, promotions, public relations, and sales managers	11.6	13.2
Operations specialties managers	14.1	16.4
Other management occupations	14.1	14.9
Business operations specialists	10.8	14.1
Financial specialists	14.9	15.9
Computer occupations	24.1	26.6
Mathematical science occupations	15.4	25.4
Architects, surveyors, and cartographers	17.0	18.5
Engineers	23.5	23.7
Drafters, engineering technicians, and mapping technicians	14.3	14.9
Life scientists	40.7	37.5
Physical scientists	34.5	33.5
Social scientists and related workers	14.4	13.8
Life, physical, and social science technicians	21.1	17.9
Counselors, social workers, and other community and social service specialists	9.4	10.8
Religious workers	11.3	13.8
Lawyers, judges, and related workers	6.7	9.0
Legal support workers	9.6	11.2
Postsecondary teachers	20.9	23.7
Preschool, elementary, middle, secondary, and special education teachers	6.7	8.5
Other teachers and instructors	13.2	14.3
Librarians, curators, and archivists	8.6	8.1
Other educational instruction and library occupations	11.1	14.8
Art and design workers	14.5	17.4
Entertainers and performers, sports, and related workers	11.0	13.2
Media and communication workers	15.6	15.1
Media and communication equipment workers	12.5	14.1
Healthcare diagnosing or treating practitioners	16.6	16.7
Health technologists and technicians	12.7	14.3
Other healthcare practitioners and technical occupations	8.3	19.0
Home health and personal care aides; and nursing assistants, orderlies, and psychiatric aides	23.5	30.3
Occupational therapy and physical therapist assistants and aides	16.2	13.6
Other healthcare support occupations	14.3	16.5
Supervisors of protective service workers	12.1	15.4

Table A-2 (continued)

Occupation (sorted by three-digit SOC code)	2010 (percent)	2021 (percent)
Firefighting and prevention workers	0.0	6.7
Law enforcement workers	7.4	7.9
Other protective service workers	12.7	13.7
Supervisors of food preparation and serving workers	25.3	26.6
Cooks and food preparation workers	32.3	26.9
Food and beverage serving workers	19.4	16.2
Other food preparation and serving related workers	32.1	21.9
Supervisors of building and grounds cleaning and maintenance workers	26.4	25.4
Building cleaning and pest control workers	36.0	36.9
Grounds maintenance workers	41.0	36.2
Supervisors of personal care and service workers	21.3	32.3
Animal care and service workers	7.8	8.3
Entertainment attendants and related workers	16.3	15.9
Personal appearance workers	33.1	34.2
Baggage porters, bellhops, and concierges	26.9	36.4
Tour and travel guides	0.0	2.2
Other personal care and service workers	20.1	16.9
Supervisors of sales workers	14.8	13.6
Retail sales workers	20.6	18.2
Sales representatives, services	10.0	11.1
Sales representatives, wholesale, and manufacturing	14.2	15.4
Other sales and related workers	13.7	15.5
Supervisors of office and administrative support workers	12.4	14.1
Communications equipment operators	11.4	17.1
Financial clerks	11.2	13.6
Information and record clerks	11.5	12.1
Material recording, scheduling, dispatching, and distributing workers	15.6	16.9
Secretaries and administrative assistants	8.2	10.2
Other office and administrative support workers	10.9	12.0
Agricultural workers	78.4	68.2
Supervisors of construction and extraction workers	3.7	3.4
Construction trades workers	16.7	16.5
Other construction and related workers	18.2	10.0
Supervisors of installation, maintenance, and repair workers	10.0	13.3
Electrical and electronic equipment mechanics, installers, and repairers	14.1	17.6
Vehicle and mobile equipment mechanics, installers, and repairers	18.8	18.7

Table A-2 (continued)

Occupation (sorted by three-digit SOC code)	2010 (percent)	2021 (percent)
Other installation, maintenance, and repair occupations	15.3	16.8
Supervisors of production workers	29.0	26.5
Assemblers and fabricators	24.0	19.8
Food processing workers	45.4	36.6
Metal workers and plastic workers	19.0	18.2
Printing workers	19.8	16.3
Textile, apparel, and furnishings workers	44.2	50.3
Plant and system operators	4.7	9.7
Other production occupations	26.5	25.1
Supervisors of transportation and material moving workers	9.2	11.5
Air transportation workers	10.2	13.2
Motor vehicle operators	20.3	26.2
Rail transportation workers	5.0	4.3
Water transportation workers	0.0	5.0
Other transportation workers	38.9	31.7
Material moving workers	24.4	20.5
Military officer special and tactical operations leaders	5.7	2.4
Military enlisted tactical operations and air/weapons specialists and crew members	6.0	6.8

Source: U.S. Census Bureau.

Table A-3

Foreign-Born Share in Industry

Industry (sorted by three-digit NAICS code)	2010 (percent)	2021 (percent)
Crop production	71.0	60.9
Animal production	10.2	15.4
Support activities for agriculture and forestry	19.4	17.1
Oil and gas extraction	14.6	17.7
Support activities for mining	23.9	23.7
Electric power generation, transmission, and distribution; natural gas distribution; sewage treatment facilities; water, steam, air-conditioning, and irrigation systems; electric and gas; and other combinations	10.5	11.3
Food manufacturing	32.4	30.8
Beverage and tobacco product manufacturing	25.6	18.2
Apparel manufacturing	52.4	43.1
Wood product manufacturing	28.8	25.6
Paper manufacturing	21.8	22.8
Printing and related support activities	23.1	21.6
Petroleum and coal products manufacturing	19.9	24.7
Chemical manufacturing	23.2	23.1
Plastics and rubber products manufacturing	19.4	17.4
Nonmetallic mineral product manufacturing	12.5	6.5
Primary metal manufacturing	13.5	13.4
Fabricated metal product manufacturing	20.5	19.4
Machinery manufacturing	15.4	14.6
Computer and electronic product manufacturing	35.5	36.5
Electrical equipment, appliance, and component manufacturing	2.9	11.4
Transportation equipment manufacturing	13.9	15.4
Furniture and related product manufacturing	12.5	16.0
Miscellaneous manufacturing	49.6	42.3
Merchant wholesalers, durable goods	15.2	13.9
Merchant wholesalers, nondurable goods	20.4	20.2
Motor vehicle and parts dealers	13.1	13.5
Furniture and home furnishings stores	13.8	14.6
Building material and garden equipment and supplies dealers	5.5	3.5
Food and beverage stores	19.3	17.8
Health and personal care stores	19.4	20.7
Gasoline stations	22.1	21.6
Clothing and clothing accessories stores	13.5	25.5
Sporting goods, hobby, book, and music stores	14.9	10.6
General merchandise stores	15.1	16.8
Miscellaneous store retailers	21.5	15.8
Non-store retailers	20.0	23.0

Table A-3 (continued)

Industry (sorted by three-digit NAICS code)	2010 (percent)	2021 (percent)
Air transportation	17.9	18.6
Rail transportation	6.2	8.4
Water transportation	46.0	34.6
Truck transportation	15.5	21.7
Transit and ground passenger transportation	32.1	39.7
Support activities for transportation	26.4	29.7
Postal service	10.4	10.4
Couriers and messengers	8.8	11.1
Warehousing and storage	27.7	23.6
Publishing industries (except internet)	15.3	20.3
Motion picture and sound recording industries	15.6	16.2
Broadcasting (except internet)	16.9	19.4
Telecommunications	17.5	20.3
Data processing, hosting, and related services	19.5	26.8
Other information services	15.8	25.9
Credit intermediation and related activities	13.2	14.7
Insurance carriers and related activities	9.2	11.4
Real estate	14.5	16.1
Rental and leasing services	20.7	21.4
Professional, scientific, and technical services	15.2	18.0
Administrative and support services	25.5	25.6
Waste management and remediation services	33.1	25.4
Education services	10.3	12.4
Ambulatory health care services	15.4	17.1
Hospitals	15.4	16.1
Nursing and residential care facilities	18.1	20.0
Social assistance	16.9	19.1
Performing arts, spectator sports, and related industries	14.0	15.7
Museums, historical sites, and similar institutions	9.6	12.6
Amusement, gambling, and recreation industries	15.1	14.3
Accommodation	30.0	27.3
Food services and drinking places	27.0	22.1
Repair and maintenance	22.0	20.8
Personal and laundry services	30.1	29.7
Religious, grantmaking, civic, professional, and similar organizations	10.6	12.1
Public finance activities; other general government and support; executive offices and legislative bodies	9.1	10.8
Administration of human resource programs	13.1	16.6
Armed forces	9.2	9.9

Source: U.S. Census Bureau.

Appendix B

Regression and Event-Study Analysis

This study documents the statistical analysis we conducted to estimate the effect of immigration flows on foreign-born workforce and online job postings. We define a state-industry-occupation combination as a labor market, where industry is defined as a three-digit NAICS code and occupation as a three-digit SOC code. We use the percent foreign-born workers in a labor market in 2010 as a generalization of our reliance on immigrant workers categories in the main text. This is a continuous measure of reliance on immigrant workers that allows us to model a labor market's incremental response to immigration. We estimate a difference-in-differences (DID) regression to estimate the effect of labor market outcomes on reliance on immigrant workers using the following model:

$$(1) \quad y_{oist} = \alpha_{ot} + \gamma_{it} + \delta_{st} + \beta fb_{ois} \times 1\{t > 2016\} + \varepsilon_{oist},$$

where y_{oist} measures outcome y in year t for a labor market that is defined by the occupation o , industry i , and state s combination. The coefficient of interest in the model, also known as the DID coefficient, is β , which captures the average effect of a 1 percentage point increase in a labor market's reliance on immigrant workers on outcome y post-2016. In addition to the DID coefficient, the model includes nonlinear occupation, industry, and state time trends, respectively. The goal of including these time trends is to make the “parallel trends” assumption in the DID plausible. In our context, the parallel trends assumption implies that if immigration trends did not shift from increasing to decreasing in 2016, outcome y would evolve similarly across labor markets regardless of their reliance on immigrant workers. Including nonlinear time trends relaxes this assumption by allowing for differential time trends across occupation, industries, and states, increasing the assumption's plausibility.

Table B-1 presents the estimated DID coefficients from equation (1) on the effect of immigration on workforce size. The outcome in column (1) measures the log of the number of foreign-born workers in

Table B-1
DID Estimates: Immigration and Labor Market Outcomes

Coefficient	Log foreign-born workers	Log total employment
	(1)	(2)
(2010 foreign-born rate) × (post-2016)	−0.0030*** (0.0008)	−0.0012*** (0.0003)
Percent foreign-born workers, 2010	12.84	12.84
Dependent mean, pre-2016	923	4,970
Implied effect (mean 2010 foreign-born percentage)	−3.8	−1.5
Number of state-industry-occupation combinations	14,863	14,863
Observations	178,356	178,356

* Significant at the 10 percent level
 ** Significant at the 5 percent level
 *** Significant at the 1 percent level

Notes: Table presents regression results for the effect of immigration disruptions that began in 2017 on labor market outcomes. All outcomes are calculated at the annual level using the 2010–21 ACS. State-industry-occupation combinations are the unit of analysis. The outcomes in columns (1) and (2) measure the log of the foreign-born workforce and overall workforce in the unit of analysis, respectively. The 2010 foreign-born rate is interacted with the post-2016 indicator, the year in which immigration disruptions started. Robust standard errors, clustered at the labor market level, are in parentheses.

a labor market in each year from 2010 to 2021. The DID coefficient suggests that a 1 percentage increase in labor market’s reliance on immigrant workers reduces the labor market’s foreign-born workforce by 0.3 percent post-2016, or by 3.8 percent post-2016 for a labor market with a mean foreign-born rate of workers in 2010 (12.84 percent of workforce).

Column (2) of Table B-1 shows that labor markets with higher reliance on immigrant workers also experienced a decline in their overall workforce size. Specifically, our estimate suggests that a 1 percentage point increase in a labor market’s reliance on immigrant workers reduces the labor market’s workforce size by 0.12 percent post-2016, or by 1.5 percent post-2016 for a labor market with a mean reliance rate. Overall, the results in Table B-1 suggest that (i) firms with higher reliance on immigrant workers experienced more significant drops in their foreign-born workforce following the shift in immigration trends and (ii) these firms were not able to fully replace these missing immigrant workers and their overall workforce declined on average.

Table B-2 examines how firms’ labor demand responded to the shift in immigration trends by examining their online job postings. The table presents the estimated DID coefficients from equation (1)

Table B-2

Relationship between Immigration and Online Job Postings

	Log job postings	Log mean minimum posted wage	Log mean number of skills in postings
Coefficient	(1)	(2)	(3)
(2010 foreign-born rate) \times (post-2016)	0.0014*** (0.0004)	0.0034*** (0.0006)	-0.0004 (0.0003)
Percent foreign born workers, 2010	12.84	12.84	12.84
Dependent mean, pre-2016	489	19,384	12.59
Implied effect (mean 2010 foreign-born percentage)	2	4.4	-0.5
Number of state-industry-occupations	14,863	14,863	14,863
Observations	178,356	178,356	178,356

* Significant at the 10 percent level

** Significant at the 5 percent level

*** Significant at the 1 percent level

Notes: Table presents regression results for the effect of immigration disruptions that began in 2017 on online job postings outcomes. All outcomes are calculated at the annual level using the 2010–21 Lightcast data. State-industry-occupation combinations are the unit of analysis. The outcome variable in column (1) is the log number of online job postings in the unit of analysis. The outcome in column (2) measures the log mean minimum wage posted at the unit of analysis. The outcome in column (3) is the log of the mean number of skills listed in a job posting at the unit of analysis. The 2010 foreign-born rates in the four different units of analysis are interacted with the post 2016 indicator, the year when immigration disruptions started. Robust standard errors, clustered at the labor market level, are in parentheses.

on the effect of immigration on various outcomes related to online job postings. The outcome in column (1) measures the log of the number of online job postings in a labor market in each year from 2010 to 2021. The DID coefficient suggests that a 1 percentage increase in labor market's reliance on immigrant workers reduces the labor market's foreign-born workforce by 0.14 percent post-2016, or by 2 percent post-2016 for a labor market with a mean foreign-born rate of workers in 2010. Columns (2) and (3) look at the posted starting wages and the log number of skills required in online job postings. The DID estimates show that firms in labor markets with higher reliance on immigrant workers increased the starting wages in their job postings by 4.4 percent on average and reduced the number of skills listed in their postings by 0.5 percent on average. Overall, the results Table B-2 suggest that firms with higher reliance on immigrant workers responded by increasing their search efforts as measured by increased online job postings, increased starting wages, and reduced skill requirements.

Next, we estimate event-study regressions to explore the dynamics of our findings and to test the validity of the parallel-trends assumption. We estimate the following regression models:

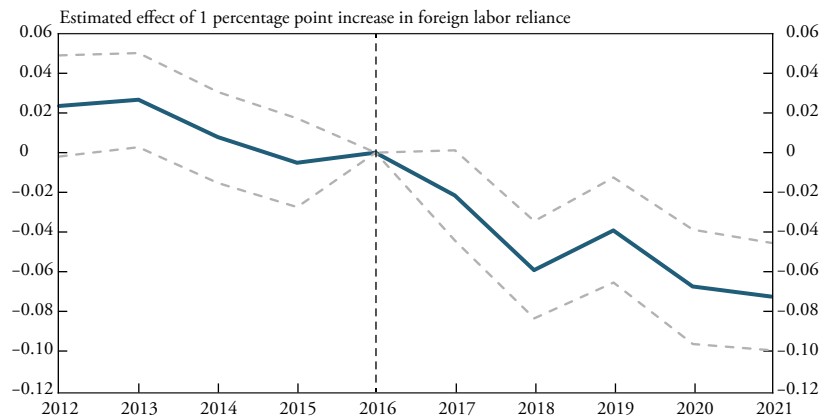
$$(2) \quad y_{oist} = \alpha_{ot} + \gamma_{it} + \delta_{st} + \sum_{k \neq 2016} \beta_k f_{ois}^b \times 1\{t = k\} + \varepsilon_{oist}.$$

Equation (2) differs from equation (1) because it is estimating “annual” DID coefficients and allows us to examine the dynamics of the evolution of the different labor market outcomes we examine. Another benefit of using an event-study model is that it allows us to test the validity of the parallel trends assumption by considering the pre-2016 coefficients on reliance on immigrant workers and by examining whether labor markets with different reliance on immigrants were not on different trends prior to 2016.

Charts B-1 through B-3 show the event-study estimates for the foreign-born rate, the log number of online job postings, and the log mean starting wage, respectively, in online job postings for the labor markets in our study. The blue line represents the estimates for a 1 percentage point increase in a labor market’s reliance on immigrant labor. The dashed gray lines represent the 95 percent confidence intervals for the estimated coefficients. As can be seen in Chart B-1, the pre-2016 coefficients on the effect of a labor market’s reliance on immigrant workers are statistically insignificant and hover around 0, while becoming negative, significant, and increasing in magnitude over time, suggesting that the effect of decreasing flows of immigration grows larger over time. The estimates in Chart B-2 show that the effect of reliance on immigrant workers on online job postings becomes positive and significant in 2020 and 2021, suggesting that while firms with greater reliance on immigrants did increase the number of online job postings relative to firms with lower reliance on immigrant workers, this increase became much more evident in 2020 and 2021. However, Chart B-3 demonstrates that starting wages increased much faster and consistently in firms that rely more on immigrant workers. This suggests that firms responded first by increasing starting wages on already existing job postings; as labor shortages became more severe, firms added more job postings to fill positions.

Chart B-1

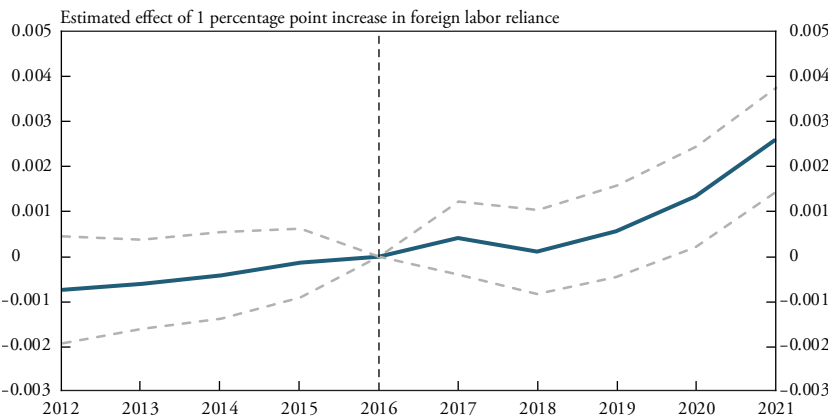
Event-Study Estimates: Foreign-Born Rate in Labor Market



Source: Authors' calculations.

Chart B-2

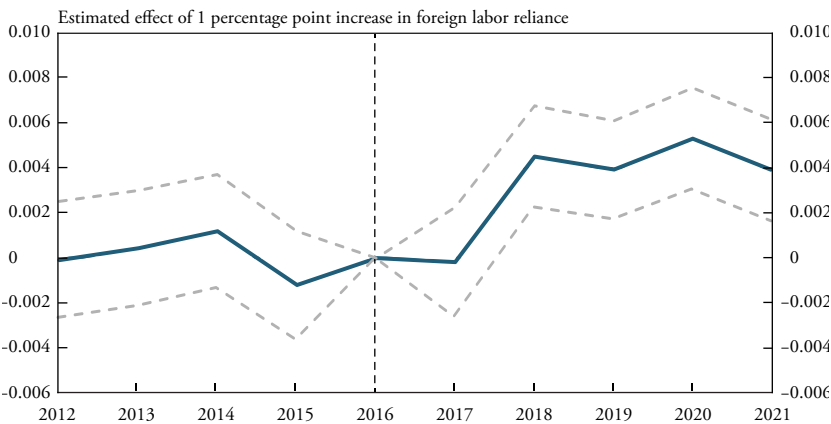
Event-Study Estimates: Log Number Online Job Postings in Labor Market



Source: Authors' calculations.

Chart B-3

Event Study Estimates: Log Starting Wage in Online Job Postings in Labor Market



Source: Authors' calculations.

Endnotes

¹Immigration has always been a crucial source of labor supply to the United States. Two main factors that have contributed to the growing importance of immigration in the labor market in recent years are that immigrant employment growth has been outpacing that of natives and that immigrants are more likely to participate in the labor market compared with natives. From 2007 to 2021, foreign-born employment grew by 1.3 percent per year on average, more than twice the pace of native-born employment. Additionally, the labor force participation rate among the foreign-born working-age population was 67 percent during these years, compared with 63 percent among natives.

²The ACS contains a 1 percent representative sample of the U.S. population conducted by the U.S. Census Bureau. Each respondent to the ACS has an associated weight corresponding to how many people they represent, which we use to approximate the size of the foreign-born workforce.

³This measure assumes that immigrants' historical location and employment decisions are not correlated with current economic conditions (for example, employment and wage growth) but do influence the location and employment decisions of new immigrants through the chain migration or social network channel, as shown in Chart 2. The thought experiment behind this measure is that if two labor markets (that is, state-industry-occupation combinations) were experiencing similar economic conditions, a prospective immigrant would prefer the market (combination) that has historically attracted more immigrants from their country of origin.

⁴One concern with our approach is that the 2011–21 period was characterized by a strong economy and tight labor markets in addition to the globally disruptive COVID-19 pandemic. These factors affected the economy and labor markets in ways not directly related to immigration flows. Thus, comparing the time series of various outcomes across different reliance groups could inappropriately attribute changes in outcomes to the drop in immigration flows. To address this concern, Appendix B presents a complex econometric model that uses the 2010 percentage of foreign-born workers in a labor market as a continuous measure of reliance on immigrant labor and a regression analysis that controls for state, industry, and occupation time trends. The goal of this exercise is to account for as many factors that affect the evolution of the labor force and online job postings in addition to immigration across labor markets, such that we can convincingly net out the effect of reduced immigration flows on labor market outcomes. Reassuringly, the results we obtain are qualitatively similar to those presented in this article, suggesting that contrasting the evolution of labor market outcomes for different labor markets based on their reliance on immigrant labor is both simple and informative.

⁵One potential explanation is that would-be immigrants to high reliance labor markets are more likely to be barred from entering the United States relative to potential immigrants to low reliance labor markets. The mean annual wage for workers in the highest reliance groups is 10 percent lower on average, and their average years of education completed is considerably lower. This is consistent with the COVID-19 pandemic and the change in immigration policy that made it more difficult for refugees and asylum seekers, who are likely to have fewer years of education than the average immigrant, from entering the United States.

⁶The low reliance group experienced higher growth than other groups from 2010 to 2013 and similar growth after 2014.

⁷We also examine the share of job postings with no education or experience requirements and the percentage of postings with at least one skill requirement. The findings are consistent with a decline in requirements in state-industry-occupation combinations with higher reliance on immigrant labor across all listed measures.

References

- Anastasopoulos, L. Jason, George J. Borjas, Gavin G. Cook, and Michael Lachanski. 2021. "Job Vacancies and Immigration: Evidence from the Mariel Supply Shock." *Journal of Human Capital*, vol. 15, no. 1, pp. 1–33. Available at <https://doi.org/10.1086/713041>
- Blau, Francine D., and Christopher Mackie, eds. 2016. "The Economic and Fiscal Consequences of Immigration." National Academies, Washington, DC. Available at <https://doi.org/10.17226/23550>
- Borjas, George J. 2003. "The Labor Demand Curve Is Downward Sloping: Reexamining the Impact of Immigration on the Labor Market." *Quarterly Journal of Economics*, vol. 118, no. 4, pp. 1335–1374. Available at <https://doi.org/10.1162/003355303322552810>
- Card, David. 2001. "Immigrant Inflows, Native Outflows, and the Local Labor Market Impacts of Higher Immigration." *Journal of Labor Economics*, vol. 19, no. 1, pp. 22–64. Available at <https://doi.org/10.1086/209979>
- Duzhak, Evgeniya A. 2023. "The Role of Immigration in U.S. Labor Market Tightness." Federal Reserve Bank of San Francisco, *Economic Letter*, no. 2023-06, February 27.
- Pholphirul, Piriya. 2013. "Immigration, Job Vacancies, and Employment Dynamics: Evidence from Thai Manufacturers." *Journal of Asian Economics*, vol. 24, pp. 1–16. Available at <https://doi.org/10.1016/j.asieco.2012.10.005>
- U.S. Customs and Border Protection. 2023. "Nationwide Enforcement Encounters: Title 8 Enforcement Actions and Title 42 Expulsions Fiscal Year 2023."
- U.S. Department of Homeland Security. 2022. "2021 Yearbook of Immigration Statistics." U.S. Department of Homeland Security, Office of Immigration Statistics.

Capital Flows and Monetary Policy in Emerging Markets around Fed Tightening Cycles

By Johannes Matschke, Alice von Ende-Becker, and Sai A. Sattiraju

The unprecedented size and rapid pace of the Federal Reserve's recent interest rate hikes—525 basis points from March 2022 to July 2023—have raised concerns about spillover effects on emerging market and developing economies. Historically, a higher U.S. federal funds rate (or a tightening of monetary policy) has been associated with international investors withdrawing capital from emerging markets, which can lead to lower economic activity and depreciating exchange rates in these markets—and, in turn, greater financial vulnerability.

To reduce capital outflows, central banks in emerging markets can tighten their own monetary policy rates to increase yields on debt securities. But raising interest rates comes with trade-offs: higher interest rates can reduce investments and thus slow economic growth. Moreover, if inflation is already at an emerging market's target rate, raising interest rates may contradict their domestic inflation mandate. Because of these trade-offs, how and why central banks in emerging markets respond to tighter monetary policy in the United States is still an empirical question.

We examine the three most recent U.S. policy tightening cycles to analyze when and why central banks in emerging markets raised their own policy rates. We find that while emerging markets sometimes raised rates in response to capital outflows or a depreciation of their

Johannes Matschke is an economist at the Federal Reserve Bank of Kansas City. Alice von Ende-Becker is a research associate, and Sai A. Sattiraju is a former research associate at the bank. This article is on the bank's website at www.KansasCityFed.org

currency resulting from U.S. monetary policy, they more frequently raised rates in response to domestic inflationary pressures. During the U.S. tightening cycle in 2004–06, initial rate hikes in the emerging markets in our sample were not well aligned with the start of the U.S. rate hikes, as most emerging markets responded to domestic inflationary pressures. However, during the start of the 2014–19 U.S. tightening cycle, several emerging markets responded to capital outflows or a depreciating exchange rate, while domestic inflationary pressures were mostly absent. During the most recent 2021–23 U.S. tightening cycle, all emerging market central banks in our sample increased their policy rate; most acted in response to domestic inflationary pressures, though many also experienced capital outflows. Taken together, these three tightening cycles suggest that central banks in emerging markets respond foremost to domestic inflationary pressures, but also to capital outflows and a depreciating exchange rate if necessary—a finding that provides new descriptive evidence on the conduct of monetary policy in emerging markets.

Section I examines how international capital flows react to changes in U.S. or emerging market policy rates. We show that tighter U.S. monetary policy leads to capital outflows from emerging markets, while a higher emerging market policy rate concurrent with a higher federal funds rate can reduce outflows. Section II explores the response of emerging market monetary policy to domestic inflation, capital flows, and the exchange rate during the three most recent tightening cycles.

I. Nonresident Capital Flows and Interest Rates

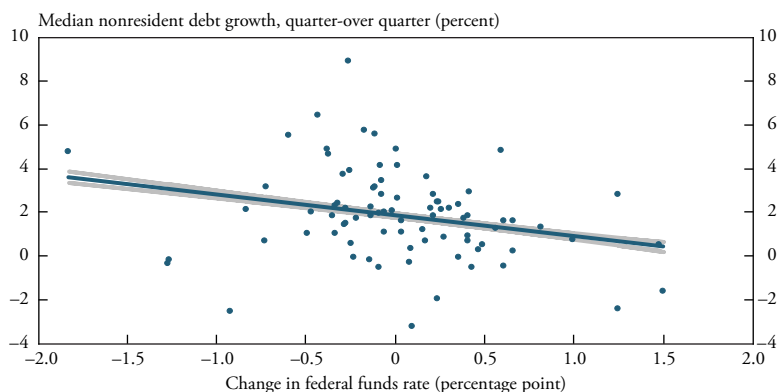
Emerging markets are more dependent on foreign capital flows than advanced economies and therefore are particularly exposed to financial spillovers from U.S. monetary policy. Interest rates in the United States transmit to emerging markets through financial flows, which affect the broader economy (see, for example, Ahmed and Zlate 2014; Fratzscher 2012; Forbes and Warnock 2012). Foreign investments in emerging markets—specifically, nonresident capital inflows—can, for example, spur economic growth when local financial markets are too small to adequately fund businesses. Capital flows also affect demand for foreign currency and thus the exchange rate. For example, if U.S. investors invest in an emerging market, financial flows will be converted to the

emerging market's currency, increasing demand for the currency and appreciating the exchange rate.

When the Federal Reserve raises the federal funds rate, international investors tend to cut back on their foreign investments through two channels. First, tighter U.S. monetary policy increases the interest rate differential between the United States and emerging markets, which makes U.S. debt securities more attractive to investors than securities in emerging markets (Bräuning and Ivashina 2020). Second, tighter U.S. monetary policy reduces risk-taking, as banks tighten lending standards after a hike in U.S. interest rates (see, for example, Miranda-Agrippino and Rey 2020; Kalemli-Özcan 2019; Bruno and Shin 2015). Because investments in emerging markets are perceived to be risky, investments in emerging markets tend to fall more than investments in advanced economies after an increase in U.S. interest rates (even controlling for the interest rate differential).

Chart 1 shows that a higher federal funds rate indeed leads to a smaller growth rate in nonresident debt invested in emerging markets. We focus on a sample of 22 emerging markets that are not subject to heavy capital controls, making them particularly sensitive to international capital flows.¹ We plot the quarterly change in the federal funds rate against the median quarterly growth rate in nonresident debt across emerging markets since 2002; a positive value implies inflows, while a negative value implies outflows.² We focus on debt investments because they account for most nonresident flows to emerging markets and are more sensitive to interest rates than other sources of investments (Avdjiev and others 2022).³ Overall, the relationship between changes in the federal funds rate and foreign debt inflows is negative; that is, tighter U.S. monetary policy slows growth in debt inflows in emerging markets and eventually leads to outflows. These outflows can have adverse effects on emerging markets' financial conditions, the exchange rate, and the broader macroeconomy (see, for example, Loipersberger and Matschke 2022; Calvo and Reinhart 2002).

Central banks in emerging markets can attempt to reduce capital outflows by raising their own policy rate. In the short term, a higher policy rate in an emerging market increases the return on credit, giving investors a stronger incentive to invest. Thus, if a central bank in

*Chart 1***Nonresident Debt Growth in Emerging Markets Has a Negative Relationship with Changes in the Federal Funds Rate**

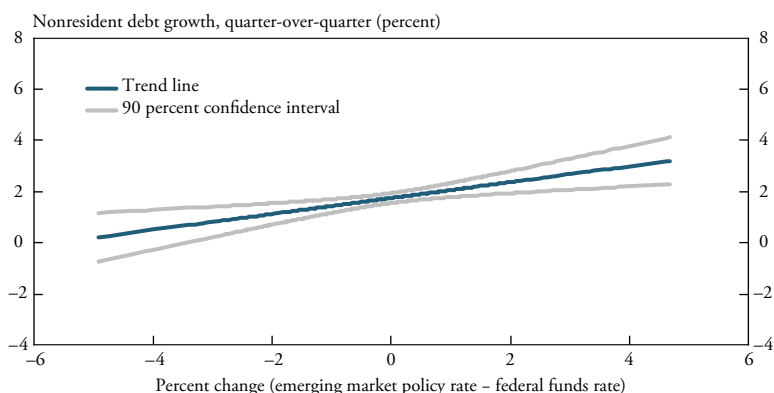
Notes: Dots indicate individual observations. The blue line represents the linear relationship between the two variables. Gray lines represent 90 percent confidence bands around the line of best fit. We use the shadow rate in Wu and Xia (2016) to proxy the effective federal funds rate at the zero lower bound over the sample period 2002–22. Sources: International Monetary Fund (Haver Analytics), Board of Governors of the Federal Reserve System, and authors' calculations.

an emerging market raises its policy rate—for example, in response to a higher federal funds rate—capital outflows may slow or even reverse. For Chart 2, we compute quarterly growth rates in nonresident debt and contrast this rate with the change in the interest rate differential (the emerging market policy rate minus the federal funds rate) over the same quarter for all emerging markets in our sample since 2002. Because of the large number of observations, we only plot a line-of-best-fit, including 90 percent confidence bands. The chart shows that an increase in the interest rate differential increases capital inflows to emerging markets or, alternatively, reduces outflows, though the relationship between the two is weaker than between the federal funds rate and foreign debt flows.

Overall, Chart 2 suggests that emerging markets can, at least in the near term, reduce financial outflows from higher U.S. interest rates. However, they may choose not to, as higher interest rates could be inconsistent with their domestic inflation mandate or their economic outlook more broadly. For example, raising the policy rate in an emerging market in response to capital outflows could have detrimental effects on the macroeconomy when inflation is below target or when output growth is weak.

Chart 2

Emerging Markets Can Slow Capital Outflows by Raising Their Own Policy Rates



Notes: The blue line represents the linear relationship between the two variables. Gray lines represent 90 percent confidence bands around the line of best fit. Individual observations are not plotted. Our sample period is 2002–22. Sources: International Monetary Fund (Haver Analytics), emerging market central banks (Haver Analytics), Board of Governors of the Federal Reserve System, and authors' calculations.

II. Monetary Policy in Emerging Markets around Fed Tightening Cycles

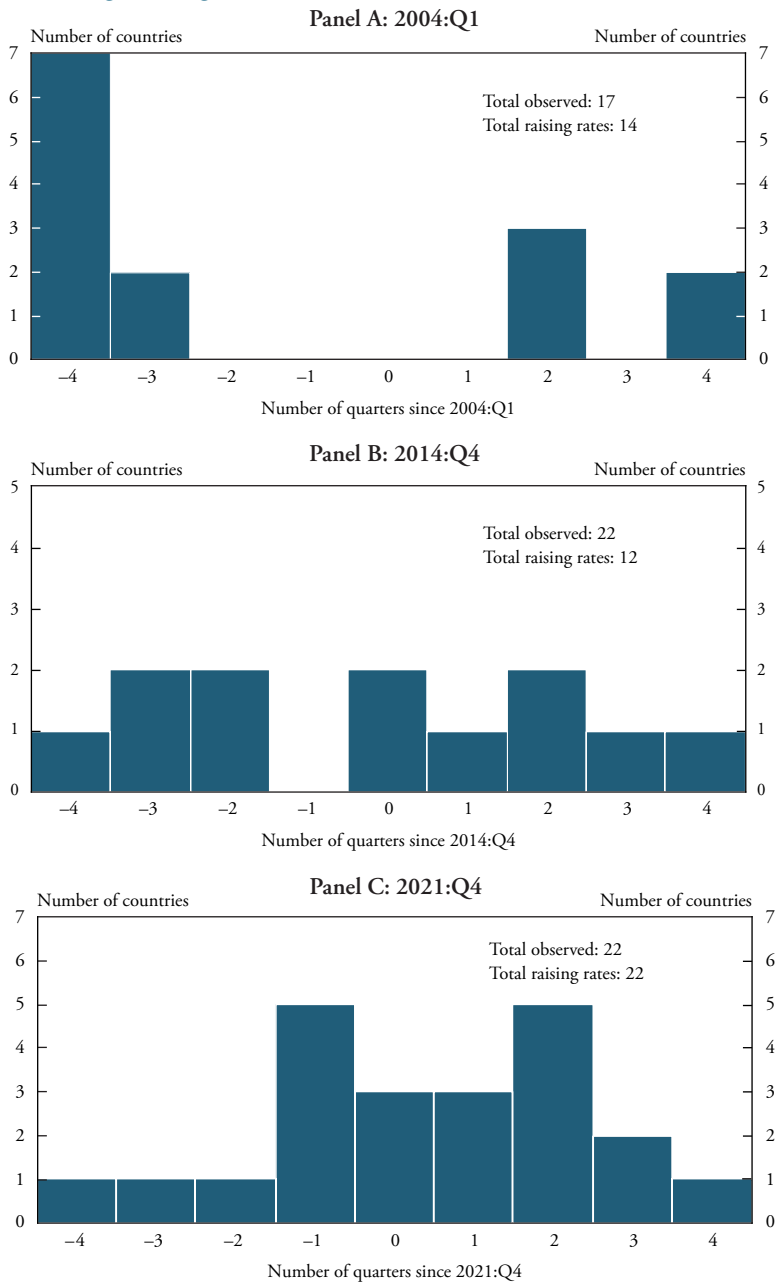
Central banks in emerging markets face potential trade-offs if they respond to changes in U.S. interest rates, as U.S. monetary policy and resulting international capital movements could be out of sync with emerging markets' domestic economies. To better understand emerging markets' policy decisions, we first examine whether central banks in our sample of 22 emerging markets raised their policy rate around three previous series of U.S. rate hikes. Specifically, we use an event-study approach around the start of each of the last three U.S. tightening cycles: 2004:Q1, 2014:Q4, and 2021:Q4. We identify these quarters based on the first increase in the federal funds rate or the shadow rate—the effective policy rate when the federal funds rate is constrained by the zero lower bound (Wu and Xia 2016). Because monetary policy changes are often signaled in advance, the shadow rate starts to increase before the Federal Reserve announces any change to the funds rate. Consequently, the start of the 2014–19 and 2021–23 U.S. tightening cycles preceded actual changes in the federal funds rate.

Chart 3 shows the number of emerging markets that raised their policy rates around these three Fed tightening cycles. For each cycle, we consider a window spanning four quarters before and after the start of the Fed cycle.⁴ During each window and quarter, we count the number of emerging markets that raised their policy rate for the first time in the event window by at least 50 basis points, which we represent by the height of the bars in the chart. We chose a 50 basis point threshold because emerging markets tend to have higher policy rates and therefore adjust interest rates in larger increments. Overall, rate hikes further away from the start of tightening cycle are less likely to be in response to U.S. interest rates.

Although many central banks raised their policy rate during all three of the U.S. tightening cycles, the timing of these rate hikes differed, with synchronization most evident around the start of the 2021–23 cycle. Around the start of the 2004–06 cycle, 14 out of 17 emerging markets raised their policy rate (for this cycle, our sample includes only 17 emerging markets due to limited data). Because most of these initial rate hikes are not well aligned with the start of the U.S. tightening cycle, these rate hikes are less likely to be a direct response to U.S. policy tightening. Around the start of the 2014–19 cycle, only 12 out of 22 emerging markets raised their policy rates; however, rate hikes were closer to the start of the Fed tightening cycle, suggesting these hikes may have been in response to U.S. policy tightening. Finally, near the start of the 2021–23 cycle, all 22 emerging markets in our sample raised their policy rates. About half of the countries started to raise their policy rates prior to the start of the Fed tightening cycle, while the other half started to raise rates in the four quarters after. In other words, rate hikes in emerging markets were more synchronized with the Fed’s policy tightening around the start of the 2021–23 cycle than during the previous two cycles.

A synchronous rate hike in an emerging market does not necessarily indicate a response to U.S. monetary policy; to assess this possibility more directly, we explore the primary drivers behind emerging markets’ rate hike decisions. In particular, we examine whether a rate hike in an emerging market coincided with rising inflation, a depreciation of the currency (that is, a decline in the exchange rate), capital outflows, or some combination of these factors. For a rate hike to be consistent with

Chart 3
Start of Tightening Cycles in Emerging Markets Relative to Start of U.S. Tightening Cycle



Notes: Each histogram counts the number of emerging markets that raised their policy rates for the first time around the last three Fed tightening cycles. The threshold for a rate hike is 50 basis points.
Sources: Board of Governors of the Federal Reserve System, emerging market central banks (Haver Analytics), and authors' calculations.

inflationary pressures, annual inflation—as measured by the Consumer Price Index (CPI)—must increase by at least one percentage point at the time of the rate hike relative to its value two quarters before. For a rate hike to be consistent with a depreciating exchange rate, the emerging market’s currency must depreciate more than 5 percent over the most recent two quarters. Finally, for a rate hike to be consistent with capital outflows, nonresident debt growth must decline either during the quarter of the rate hike or the quarter before.

Table 1 shows that rate hikes in our emerging market sample can be related to domestic inflationary pressures but also to international factors such as currency depreciation and capital outflows, which are influenced by U.S. monetary policy. The importance of each of these factors varies with the tightening cycle. At the beginning of the 2004–06 tightening cycle, half of the central banks raised policy rates amid inflationary pressures, while international factors played a smaller role. At the beginning of the 2014–19 cycle, 12 out of 22 central banks raised their policy rates. The majority of these 12 banks responded to international factors: 73 percent responded to capital outflows, and 58 percent responded to a depreciating exchange rate, while only 17 percent responded to elevated inflationary pressures. All central banks in our sample raised their policy rate at the beginning of the 2021–23 cycle. Among these banks, 73 percent responded to inflationary pressures, 67 percent to capital outflows, and 32 percent to a depreciating exchange rate. Taken together, evidence from the last 20 years suggests that while most central banks seemed to raise rates in response to inflationary pressures, some also raised rates in response to U.S. rate hikes, particularly during the 2014–19 cycle. However, the extraordinary synchronization during the 2021–23 cycle visible in Panel C of Chart 3 appears to be driven by domestic inflation, which comoved across the globe, rather than a response to U.S. monetary policy.

The 2021–23 U.S. tightening cycle followed the onset of the global COVID-19 pandemic in 2020. The pandemic resulted in a unique combination of lockdowns that led to widespread supply chain issues and accommodative fiscal and monetary policy to stimulate demand. This supply and demand imbalance during the economic recovery contributed to rising inflation in both advanced and emerging economies.

Table 1
Factors Underlying Rate Hike Decisions in Emerging Markets

Factors		2004–06 cycle (percent)	2014–19 cycle (percent)	2021–23 cycle (percent)
Domestic	Inflation	50	17	73
International	Depreciation	23	58	32
	Capital outflows	20	73	67

Notes: Each cell represents the share of countries that raised their policy rates in line with rising inflation, currency depreciation, or capital outflows during each of the last three Fed tightening cycles. A rate hike can be consistent with multiple factors; therefore, each column does not sum up to 100.
Sources: International Monetary Fund (Haver Analytics); Bloomberg; Ha, Kose, and Ohnsorge (2021); and authors' calculations.

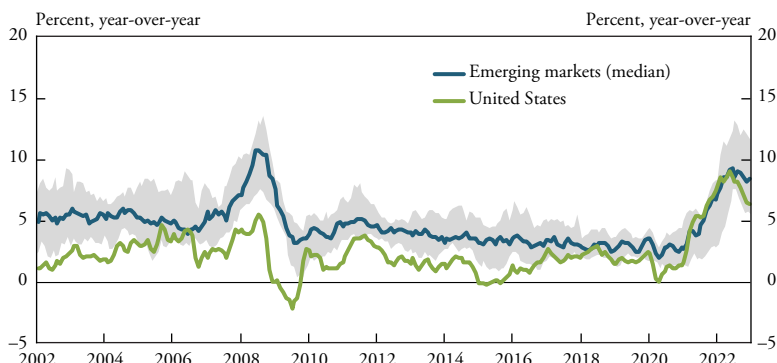
Because central banks have a mandate to stabilize prices, the global inflation cycle reversed the course of monetary policy and resulted in synchronous interest rate hikes among advanced and emerging markets.

Chart 4 shows that inflation was closely aligned across emerging markets and the United States during 2021 and most of 2022. The chart displays median annualized CPI inflation across emerging markets in blue along with 25th–75th percentile bands in gray. The green line represents U.S. CPI inflation. The blue and green lines are almost indistinguishable during the inflation surge in 2021 and the first half of 2022, when inflation across emerging markets and the United States accelerated in lockstep. This similarity across markets contrasts with previous years, when inflation rates for the most part differed both across emerging markets and relative to the United States. Toward the end of 2022, however, inflation rates once again started to diverge.

Although central banks' responses to inflation differ based on their inflation targets, the post-COVID-19 surge in inflation caused a broad and sustained increase in policy rates around the world. Chart 5 shows the median policy rate across emerging markets (blue line) along with 25th–75th percentile bands alongside the federal funds rate for the United States (green line), with each country-specific series demeaned to account for level differences. Policy rates in the United States and emerging markets clearly comoved during the global inflation cycle at a level unprecedented over the last 20 years, as central banks around the world responded to elevated inflation.

Chart 4

CPI Inflation in Emerging Markets and the United States Surged in 2021–22

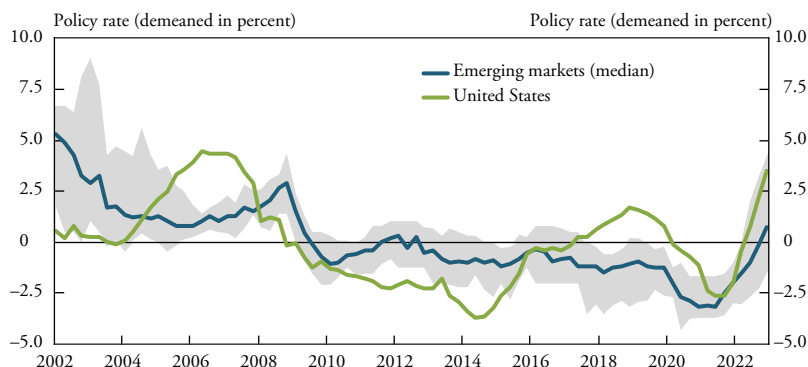


Note: Shaded areas highlight the 25th–75th percentile range in inflation across emerging markets.

Sources: U.S. Bureau of Labor Statistics; Ha, Kose, and Ohnsorge (2021); and authors' calculations.

Chart 5

Policy Rates in Emerging Markets and the United States Comoved in 2022



Notes: Policy rates for each country are demeaned to account for level differences. The federal funds rate is replaced with the shadow rate for periods in which the policy rate was constrained by the zero lower bound. Shaded areas highlight the 25th–75th percentile range in policy rates across emerging markets.

Sources: Board of Governors of the Federal Reserve System, emerging market central banks (Haver Analytics), and authors' calculations.

Conclusion

Higher U.S. interest rates can reduce capital flows to emerging markets and depreciate their exchange rates, which may impair their macroeconomic growth. Foreign economic conditions in turn influence the United States through trade and financial linkages, so policymakers in the United States and emerging markets alike closely watch capital flows in response to U.S. monetary policy. One way for central banks in emerging markets to prevent capital outflows is to increase their policy rate in response to a higher federal funds rate, thereby incentivizing international investors to shift funds toward emerging markets. However, emerging markets may not always want to implement this strategy, as a higher policy rate tends to reduce domestic economic activity over time and could be out of sync with domestic price pressures.

We find that some emerging markets did respond to international spillovers by raising rates during the start of the 2014–19 U.S. tightening cycle. However, during the start of the 2004–06 and 2021–23 U.S. tightening cycles, emerging markets raised their policy rates primarily in response to domestic inflationary pressures.

Our analysis provides evidence that monetary policy in emerging markets differs from policy in advanced economies. Central banks in larger advanced economies tend to focus on inflation or employment and less on capital flows. In emerging markets, however, central banks also respond to changes in capital flows and the exchange rate, as these have a disproportionately larger effect on the emerging market economy if unaddressed.

Endnotes

¹Our sample comprises Bolivia, Brazil, Bulgaria, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, Georgia, Guatemala, Hungary, Indonesia, Kazakhstan, Mexico, Nicaragua, Nigeria, Peru, Poland, Qatar, Saudi Arabia, South Africa, and Uganda.

²We replace the federal funds rate with the shadow rate at the zero lower bound (ZLB). The shadow rate measures the effective nominal interest rate when the federal funds rate is constrained by its effective lower bound. The shadow rate accounts for quantitative easing and is therefore generally negative at the ZLB.

³Foreign debt flows are based on the percent change in the International Investment Position (IIP) of nonresidents reported by the IMF. We look at portfolio debt and credit flows lumped into the “other” category. These positions are based on market values and therefore include price and quantity effects.

⁴The window helps us avoid misclassifying a rate hike in an emerging market as coinciding with the start of a U.S. tightening cycle when the central bank in fact started to raise interest rates earlier.

References

- Ahmed, Shaghil, and Andrei Zlate. 2014. "Capital Flows to Emerging Market Economies: A Brave New World?" *Journal of International Money and Finance*, vol. 48B, pp. 221–248. Available at <https://doi.org/10.1016/j.jimonfin.2014.05.015>
- Avdjiev, Stefan, Bryan Hardy, Şebnem Kalemli-Özcan, and Luis Servén. 2022. "Gross Capital Flows by Banks, Corporates, and Sovereigns." *Journal of the European Economic Association*, vol. 20, no. 5, pp. 2098–2135. Available at <https://doi.org/10.1093/jeea/jvac038>
- Bräuning, Falk, and Victoria Ivashina. 2020. "U.S. Monetary Policy and Emerging Market Credit Cycles." *Journal of Monetary Economics*, vol. 112, pp. 57–76. Available at <https://doi.org/10.1016/j.jmoneco.2019.02.005>
- Bruno, Valentina, and Hyun Song Shin. 2015. "Capital Flows and the Risk-Taking Channel of Monetary Policy." *Journal of Monetary Economics*, vol. 71, pp. 119–132. Available at <https://doi.org/10.1016/j.jmoneco.2014.11.011>
- Calvo, Guillermo A., and Carmen Reinhart. 2002. "Fear of Floating." *Quarterly Journal of Economics*, vol. 117, no. 2, pp. 379–408. Available at <https://doi.org/10.1162/003355302753650274>
- Forbes, Kristin J., and Francis E. Warnock. 2012. "Capital Flow Waves: Surges, Stops, Flight, and Retrenchment." *Journal of International Economics*, vol. 88, no. 2, pp. 235–251. Available at <https://doi.org/10.1016/j.jinteco.2012.03.006>
- Fratzscher, Marcel. 2012. "Capital Flows, Push versus Pull Factors and the Global Financial Crisis." *Journal of International Economics*, vol. 88, no. 2, pp. 341–356. Available at <https://doi.org/10.1016/j.jinteco.2012.05.003>
- Ha, Jongrim, M. Ayhan Kose, and Franziska Ohnsorge. 2021. "One-Stop Source: A Global Database of Inflation." World Bank Group, Policy Research Working Paper no. 9737, July. Available at <https://doi.org/10.1596/1813-9450-9737>
- Kalemli-Özcan, Şebnem. 2019. "U.S. Monetary Policy and International Risk Spillovers." National Bureau of Economic Research, working paper no. 26297, September. Available at <https://doi.org/10.3386/w26297>
- Loipersberger, Florian, and Johannes Matschke. 2022. "Financial Cycles and Domestic Policy Choices." *European Economic Review*, vol. 143. Available at <https://doi.org/10.1016/j.euroecorev.2022.104034>
- Miranda-Agrippino, Silvia, and Hélène Rey. 2020. "U.S. Monetary Policy and the Global Financial Cycle." *Review of Economic Studies*, vol. 87, no. 6, pp. 2754–2776. Available at <https://doi.org/10.1093/restud/rdaa019>
- Wu, Jing Cynthia, and Fan Dora Xia. 2016. "Measuring the Macroeconomic Impact of Monetary Policy at the Zero Lower Bound." *Journal of Money, Credit and Banking*, vol. 48, no. 2-3, pp. 253–291. Available at <https://doi.org/10.1111/jmcb.12300>

Do the Effects of Interest Rate Changes Depend on Inflation?

By Dimitris Christopoulos, Peter McAdam, and Elias Tzavalis

Inflation, as measured by the 12-month change in the consumer price index, fell from a peak of 9 percent in June 2022 to 3.7 percent in August 2023. Despite this decline, inflation remains well above the Federal Open Market Committee's (FOMC) longer-run objective of 2 percent—an objective not met since February 2021. This performance stands in marked contrast to recent decades (starting in the mid-1990s), when inflation generally averaged below 2 percent. However, that benign era was preceded by the high inflation of the 1970s and 1980s.

Accordingly, many economists have interpreted inflation rates over time as belonging to different regimes or states—for example, being persistently “high” or “low.” These regimes may influence how monetary policy affects the economy: for example, high inflation reduces real (that is, inflation-adjusted) interest rates, which influence the demand for interest-sensitive goods and add to uncertainty. In this article, we assess whether U.S. monetary policy (represented by the path of the federal funds rate) has different effects on the economy depending on which inflation state the economy is in. We find that the economy reacts more slowly and with more volatility to a change in monetary policy in a high-inflation state—that is, when our measure of inflation expectations exceeds a value of around 4 percent—than in a

Dimitris Christopoulos and Elias Tzavalis are professors of economics at the Athens University of Economics and Business. Peter McAdam is a senior research and policy advisor at the Federal Reserve Bank of Kansas City. This article is on the bank's website at www.KansasCityFed.org

low-inflation state. We also find that in a high-inflation state, interest rates must be held higher for longer to bring inflation back down relative to a low-inflation state.

Section I discusses the evolution of inflation and the federal funds rate since the 1970s and broadly tries to identify high- and low-inflation regimes. Section II shows how different economic variables react to a positive monetary policy shock in the different inflation regimes using a statistical model. Section III examines why the effects of monetary policy may depend on the economy's inflation regime.

I. Inflation and the Federal Funds Rate since the 1970s

To assess how different inflation regimes might influence the effect of monetary policy, we first look at how inflation and the federal funds rate have evolved over time. Chart 1 shows monthly annualized inflation (blue line) alongside the monthly value of the federal funds rate (green line) from 1970 through 2020. The data appear volatile over the full sample, with periods of high and low inflation and high and low interest rates. Given this long and diverse period of inflation, the reaction of monetary policymakers has likely varied over time as well—in terms of the importance they attach to different economic objectives over time, how they conduct monetary policy, and how their changes to monetary policy transmit to the economy.

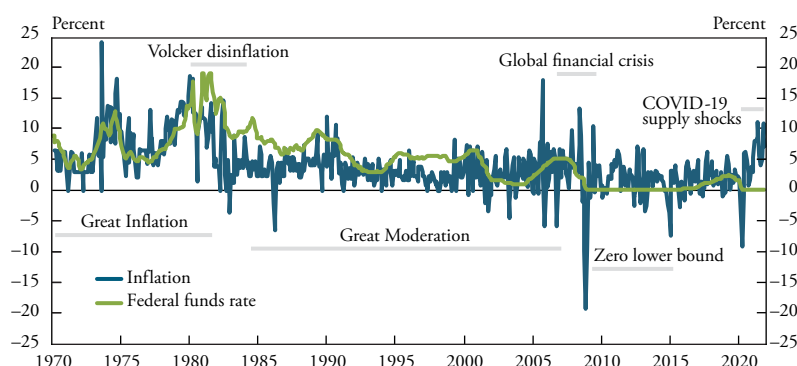
Monetary policy regimes

At a broad level and across a variety of methodologies, many researchers have tended to categorize the evolution of monetary policy into different regimes or states (see, for example, Sims and Zha 2006; Davig and Leeper 2007, 2008; Liu, Waggoner, and Zha 2009; Bianchi 2013; Davig and Doh 2014; Ascari and Haber 2022). These narratively defined regimes offer a useful way to think about the evolution of the economy and of policy. However, they can also provide a useful benchmark for the model-partitioned regimes that our statistical model identifies, which we will discuss in Section II. The regimes that follow have been generally accepted in extant research.

Great Inflation. Accommodative monetary policy in the 1970s set the stage for high inflation, exacerbated by relatively loose fiscal policies, oil shocks, and the breakdown of the Bretton Woods system of

Chart 1

Inflation and the Federal Funds Rate, 1970–2021



Sources: Board of Governors of the Federal Reserve System and U.S. Bureau of Labor Statistics, both accessed through the Federal Reserve Bank of St. Louis (FRED).

fixed exchange rates. During this period, inflation climbed to historic double-digit values, and the economy entered four separate recessions. This Great Inflation period may be considered to begin as early as the mid-1960s and last until 1982 (the latter years also spanning the “Volcker disinflation”).

Volcker disinflation. To try to control the Great Inflation, then-Federal Reserve Chair Paul Volcker worked to bring down inflation at the cost of a high and volatile federal funds rate and two deep recessions. From the 1970s until the early 1980s, inflation trended up to atypically high levels before starting to decline in the mid-1980s. Accordingly, the federal funds rate rose drastically too, reaching a peak of around 20 percent in 1980–81. Interest rates during this period were both higher and sustained at higher levels for longer than during the Great Inflation period.

Great Moderation. The monetary policies of the Volcker regime may have set the stage for a long period of macroeconomic stability that started in the mid-1980s and lasted until just before the global financial crisis in 2007. Although inflation was still quite volatile during this period, average inflation values were generally below or around 2 percent.

Global financial crisis and zero lower bound episode. The global financial crisis of 2007–09 was characterized by very low inflation rates, which thereafter fluctuated around 2 percent. In policy terms, the period was exemplified by highly accommodative monetary and fiscal policies. From 2009 until around 2015, in a bid to stimulate

the economy, the federal funds rate was reduced to around zero, and central banks around the world set interest rates at very low (sometimes even negative) values (this period is marked as the zero lower bound in Chart 1). At the same time, central banks began engaging in a range of unconventional policies such as quantitative easing and forward guidance (Bundick and Smith 2022). These actions reflected not only the severity of the economic crisis and depressed inflation but also that central banks deemed traditional policy responses insufficiently potent.

COVID-19 and global disruptions. Toward the end of the sample, from 2020 onward, the COVID-19 pandemic and a variety of associated shocks produced global supply-chain disruptions. Accordingly, starting in early 2021, both inflation and the federal funds rate began to rise as demand pressures took hold.

Relationships between inflation and monetary policy over time

Both Chart 1 and the associated regimes help illustrate that the relationship between inflation and the federal funds rate is by no means monotonic. In the early 1970s, high inflation was succeeded by a strong monetary policy response, with several hikes to the federal funds rate. In late 2008, however, inflation was above 2 percent (the Fed's inflation target since 2012), but the federal funds rate was barely above zero.

Therefore, inflation and interest rates need not move in lockstep over time. Different shocks and economic conditions may warrant different monetary policy responses. Moreover, the Federal Reserve's monetary policy framework has changed over this 1970–2020 sample from responding to the exchange rate and money supply to targeting inflation. Given that the effect of changes in monetary policy is likely to be sensitive to these distinct policy and economic states, our analysis in the next section uses a framework that tries to assess the state-dependency of monetary policy.

II. Monetary Policy in High- and Low-Inflation Regimes

To assess whether persistently high or low inflation influences the conduct of monetary policy, we estimate a statistical model that allows for monetary policy responses to differ depending on the state of the economy. Specifically, we use a threshold vector autoregression model (TVAR), which allows for different parameter values and model

responses when a “threshold variable” exceeds a certain estimated value. In our case, the threshold variable is a 20-month moving average of inflation rates.¹ We think of this as a measure of inflation expectations. We use this measure to capture the idea that different monetary policy states are likely to emerge only after protracted changes in inflation, not discrete, temporary spikes.

First, we examine how the TVAR model, when estimated, partitions the data into high- and low-inflation regimes and evaluate whether this partitioning aligns with the narrative regimes identified in the previous section. Second, we examine how the economy responds to an unanticipated increase in interest rates in each inflation state.

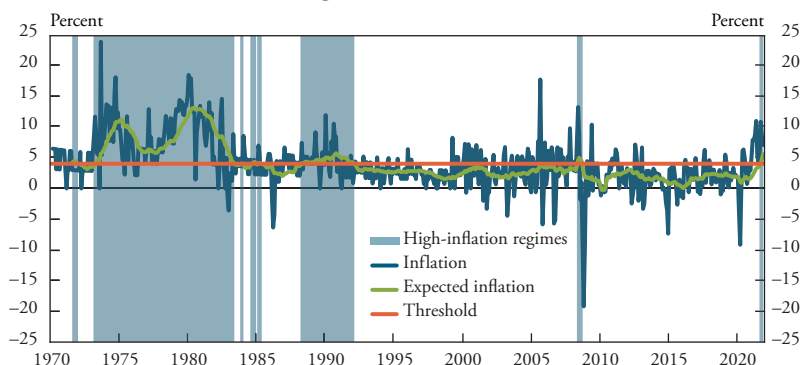
A graphical perspective on inflation and inflation regimes

Estimating the TVAR yields a threshold value of 4.05 percent for expected inflation, suggesting the economy is in a high-inflation state when expected inflation is above 4.05 percent and a low-inflation state otherwise. The model implies that the effect of monetary policy would be different in each of these two regimes. Chart 2 plots monthly annualized inflation rates in blue and trend or expected inflation (as measured by a moving average) in green. The horizontal orange line denotes the empirically determined threshold value. If expected inflation exceeds that threshold value, the economy is categorized as being in a high-inflation regime. Otherwise, the economy is in a low- (or “normal”) inflation regime. The blue shading denotes periods in which the economy is in a high-inflation regime. For example, from the mid-1970s to the mid-1980s, expected inflation exceeded the threshold value of 4.05; thus, the economy is considered to have been in a high-inflation regime.

Comparing Chart 2 with Chart 1 reveals that the TVAR-identified high- and low-inflation regimes largely match up with the descriptive regimes identified in the previous section. As Chart 2 shows, the economy entered high-inflation states near the start of the sample, during a protracted window around 1988–92 and, more briefly, around late 2008 and the end of 2021. These periods are roughly consistent with the Great Inflation, Volcker disinflation, global financial crisis, and pandemic shock periods described in the previous section. Overall, the high-inflation states in Chart 2 represent around 40 percent of the sample.

Chart 2

Inflation and Identified High-Inflation States, 1970–2021



Notes: Our measure of expected inflation is a 20-month moving average of the inflation series. The orange horizontal line, which denotes the threshold value of inflation (around 4 percent), is estimated by our TVAR model. The shaded areas represent periods when expected inflation exceeds the threshold value.

Sources: Board of Governors of the Federal Reserve System (FRED), U.S. Bureau of Labor Statistics (FRED), and authors' calculations.

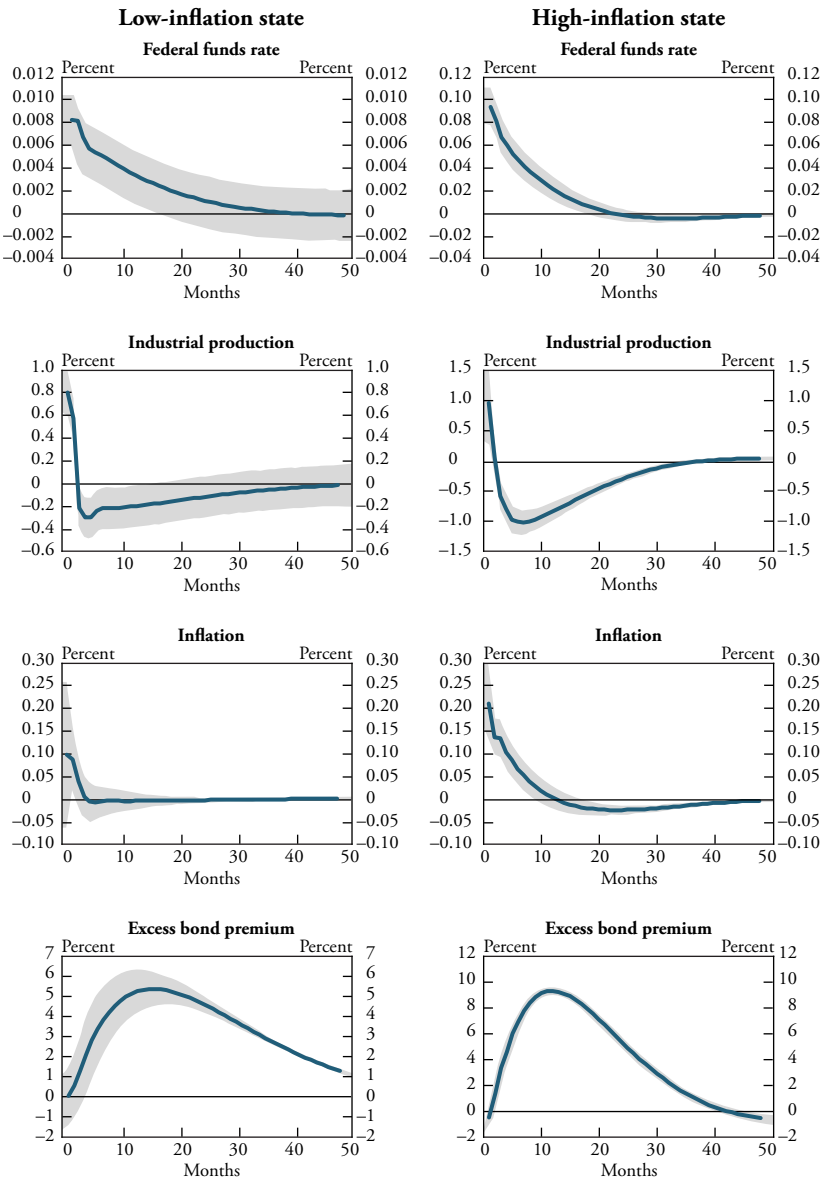
Note that the estimated threshold value of 4.05 percent exceeds the FOMC's 2 percent target, suggesting that when inflation is below this value, monetary policy and monetary policy responses are within some normal range. Accordingly, when inflation is within the zero to 4 percent range, the path of the federal funds rate may be reasonably approximated by some standard feedback rule such as a Taylor rule. However, when inflation is outside of that zero to 4 percent range, monetary policy may have to depart from such a rule—for example, by applying higher weights to policy targets (see Davig and Leeper 2008).

Graphical analysis of an unanticipated increase in interest rates

Chart 3 shows the effect of a one-standard-deviation increase in the federal funds rate when the economy is in the low-inflation regime (left column) or high-inflation regime (right column) over a 48-month reporting horizon. In particular, the panels show the responses of four variables commonly used to examine the transmission of monetary policy: the federal funds rate, industrial production (a measure of output), inflation, and the excess bond premium (a measure of firms' borrowing conditions).

Overall, the responses to a one-deviation increase to the federal funds rate follow a pattern consistent with many previous studies on the so-called monetary transmission mechanism: both inflation and output

Chart 3
Impulse Responses to a One-Standard-Deviation Increase
in the Federal Funds Rate



Note: Gray bands indicate 90 percent confidence intervals.
Source: Authors' calculations based on the estimated TVAR model.

(as measured by industrial production) fall after an initial lag, while the bond premium rises, reflecting the tighter monetary policy conditions. Because the increase in interest rates is temporary, all series eventually return to the baseline. Higher interest rates reduce demand for goods and services in the economy, and this reduction in demand in turn dampens inflation. Because both prices and output change slowly, it takes time for the series to return to their baselines, and some series may be temporarily below (or above) base until the full adjustment is complete.

Although the qualitative pattern is essentially the same in both low- and high-inflation regimes, the quantitative effects are not. In the low-inflation state, for instance, output and inflation revert to their baselines much more quickly and with much less volatility (fewer swings) than in the high-inflation state. Industrial output growth falls below zero three months after the shock (at a value of around -1.5 percent) and reverts quite rapidly back to its baseline. Inflation falls below zero over the same horizon but reverts to its baseline even more quickly. However, in the high-inflation state, the responses of inflation and output are both more volatile and more persistent (meaning, both take longer to return to their baselines).

Finally, comparing the responses of the federal funds rate in Chart 3 suggest that monetary policy must work harder in high-inflation regimes to maintain roughly the same outcomes. The initial increase in the federal funds rate is smaller in the low-inflation state than the high-inflation one, suggesting policymakers need to raise the federal funds rate by a greater amount to influence output, inflation, and the excess bond premium when inflation is high. In other words, in the high-inflation regime, monetary policy must be more aggressive to force inflation back to its target. This finding is consistent with current developments: since March 2022, the FOMC has engaged in a rapid upward movement of the federal funds rate, as it has become clear that increases in inflation were higher and more persistent than initially thought.

III. Why Should the Effect of Monetary Policy Depend on Movements in Inflation?

Having presented results showing that the effect of monetary policy changes on the economy differs depending on the prevailing inflation regime, we now touch upon why we might expect and rationalize such an outcome.

In many economic models, monetary policy is assumed to influence the economy precisely because of “price stickiness”—the idea that prices are slow to adjust over time to various economic shocks and events. Price stickiness slows the response of the economy to any shock and thus essentially transfers some of the effects of a shock to output and employment—variables that the Fed also cares about.

We might also expect the degree of price stickiness itself to change depending on the state of the economy. When inflation is low and stable, firms set and reset prices in a manner reflecting that environment. However, if inflation is high and volatile (or is expected to be as such), profit-maximizing firms will likely change prices much more rapidly. This change in firms’ price-setting behavior would have implications for how monetary policy influences the economy. Indeed, several researchers (for example, Davig and Leeper 2007, 2008) have posited a threshold monetary policy rule in which the reaction of interest rates to inflation depends on how far inflation is away from its target.

Likewise, when inflation is high, long-run inflation expectations are more likely to become unanchored (in other words, people may stop believing inflation will eventually return to its target). Unanchored inflation expectations are a key concern for monetary policymakers, and so when inflation does drift up (or down) to extreme levels, monetary policymakers may react more forcefully.

Finally, high inflation reduces real (that is, inflation-adjusted) interest rates, which influence the demand for investment, durable goods, and housing—as well as adding to uncertainty. Inflation also redistributes resources across agents (such as savers and lenders), who may have very different spending and consumption patterns.

Conclusions

In this article, we examine whether monetary policy has different effects on key economic variables based on the economy’s inflation regime. We find that when a measure of expected inflation exceeds a value of around 4 percent—our threshold for a high- versus low-inflation regime—the effect of monetary policy changes. Specifically, we find that in a high-inflation state, interest rates must be held higher for longer to bring inflation back down relative to a low-inflation state.

Endnote

¹In a more extensive research article (Christopoulos, McAdam, and Tzavalis 2023), we also look at TVARs and monetary policy shocks but do so in a way that includes some additional statistical devices (namely, copulas) to better capture omitted “endogenous” interactions in the VAR. The model comprises four monthly variables: the growth of industrial production (a measure of output), the rate of inflation, the federal funds rate, and the excess bond premium. Inflation and output growth are expressed in annualized terms. The excess bond premium is taken from Gilchrist and Zakrajšek (2012) and begins in 1973. This variable is added to capture financial and corporate interactions in the transmission of monetary policy. These four variables have served as a benchmark in many VAR monetary studies (see Bauer and Swanson 2022; Gertler and Karadi 2015). The ordering of the variables in the TVAR allows us to implement the unexpected monetary change (or shock) in a manner consistent with theory (namely, a Cholesky ordering).

References

- Ascari, Guido, and Timo Haber. 2022. "Non-Linearities, State-Dependent Prices and the Transmission Mechanism of Monetary Policy." *Economic Journal*, vol. 132, no. 641, pp. 37–57. Available at <https://doi.org/10.1093/ej/ueab049>
- Bauer, Michael D., and Eric T. Swanson. 2022. "A Reassessment of Monetary Policy Surprises and High-Frequency Identification." National Bureau of Economic Research, working paper no. 29939, April. Available at <https://doi.org/10.3386/w29939>
- Bianchi, Francesco. 2013. "Regime Switches, Agents' Beliefs, and Post-World War II U.S. Macroeconomic Dynamics." *Review of Economic Studies*, vol. 80, no. 2, pp. 463–490. Available at <https://doi.org/10.1093/restud/rds032>
- Bundick, Brent, and A. Lee Smith. 2022. "Evaluating Quantitative Easing: The Importance of Accounting for Forward Guidance." Federal Reserve Bank of Kansas City, *Economic Review*, vol. 107, no. 3, pp. 5–20. Available at <https://doi.org/10.18651/ER/v107n3BundickSmith>
- Christopoulos, Dimitris, Peter McAdam, and Elias Tzavalis. 2023. "Threshold Endogeneity in Threshold VARs: An Application to Monetary State Dependence." Federal Reserve Bank of Kansas City, Research Working Paper no. 23-09, July. Available at <https://doi.org/10.18651/RWP2023-09>
- Davig, Troy, and Taeyoung Doh. 2014. "Monetary Policy Regime Shifts and Inflation Persistence." *Review of Economics and Statistics*, vol. 96, no. 5, pp. 862–875. Available at https://doi.org/10.1162/REST_a_00415
- Davig, Troy, and Eric M. Leeper. 2008. "Endogenous Monetary Policy Regime Change." *NBER International Seminar on Macroeconomics*, vol. 2006, no. 1, pp. 345–391. Available at <https://doi.org/10.1086/653984>
- . 2007. "Generalizing the Taylor Principle." *American Economic Review*, vol. 97, no. 3, pp. 607–635. Available at <https://doi.org/10.1257/aer.97.3.607>
- Gilchrist, Simon, and Egon Zakrajšek. 2012. "Credit Spreads and Business Cycle Fluctuations." *American Economic Review*, vol. 102, no. 4, pp. 1692–1720. Available at <https://doi.org/10.1257/aer.102.4.1692>
- Liu, Zheng, Daniel F. Waggoner, and Tao Zha. 2009. "Asymmetric Expectation Effects of Regime Shifts in Monetary Policy." *Review of Economic Dynamics*, vol. 12, no. 2, pp. 284–303. Available at <https://doi.org/10.1016/j.red.2008.10.001>
- Sims, Christopher A., and Tao Zha. 2006. "Were There Regime Switches in U.S. Monetary Policy?" *American Economic Review*, vol. 96, no. 1, pp. 54–81. Available at <https://doi.org/10.1257/000282806776157678>

Economic Review

PRESIDENT AND CHIEF EXECUTIVE OFFICER

Jeffrey R. Schmid

EXECUTIVE VICE PRESIDENT AND DIRECTOR OF RESEARCH

Joseph Gruber

EDITOR-IN-CHIEF

Alison Felix, Senior Policy Advisor

MANAGING EDITOR

Elizabeth Cook, Communications Consultant

ASSOCIATE EDITORS

Jason P. Brown, Vice President and Economist
Peter McAdam, Senior Research and Policy Officer
Huixin Bi, Research and Policy Officer
Stefan Jacewitz, Research and Policy Officer
José Mustre-del-Río, Research and Policy Officer
W. Blake Marsh, Senior Economist
Jordan Rappaport, Senior Economist

RESEARCH STAFF

Nathan Kauffman, Senior Vice President and Branch Executive, Omaha Branch
A. Lee Smith, Senior Vice President
Chad Wilkerson, Senior Vice President and Branch Executive, Oklahoma City Branch
Nicholas Sly, Vice President and Branch Executive, Denver Branch
Brent Bundick, Senior Research and Policy Advisor
Fumiko Hayashi, Senior Policy Advisor
Andrew Glover, Research and Policy Advisor
Nida Çakır Melek, Senior Economist
Cortney Cowley, Senior Economist
Karlye Dilts Stedman, Senior Economist
Taeyoung Doh, Senior Economist
Yusuf Mercan, Senior Economist
Rajdeep Sengupta, Senior Economist
Didem Tüzemen, Senior Economist
Elior Cohen, Economist
Amaze Lusompa, Economist
Johannes Matschke, Economist
Jordan Pandolfo, Economist
Aditi Routh, Economist
Francisco Scott, Economist
Padma Sharma, Economist
Ying Lei Toh, Economist
Thomas R. Cook, Senior Data Scientist

EDITORIAL SUPPORT

Kara McKeever, Copyeditor
Beth Norman, Layout Designer

Volume 108, Number 4

The *Economic Review* (ISSN0161-2387) is published quarterly by the Federal Reserve Bank of Kansas City, 1 Memorial Drive, Kansas City, Missouri 64198-0001. Subscriptions and additional copies are available without charge. Send requests to the Public Affairs Department, Federal Reserve Bank of Kansas City, 1 Memorial Drive, Kansas City, Missouri 64198-0001. Periodical postage paid at Kansas City, Missouri.

POSTMASTER: Send address changes to *Economic Review*, Public Affairs Department, Federal Reserve Bank of Kansas City, 1 Memorial Drive, Kansas City, Missouri 64198-0001. The views expressed are those of the authors and do not necessarily reflect the positions of the Federal Reserve Bank of Kansas City or the Federal Reserve System. If any material is reproduced from this publication, please credit the source.