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WORKING PAPER

Estimating hysteresis effects

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13 | 2020

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Estimating Hysteresis Effects ^{*}

Francesco Furlanetto[†] Ørjan Robstad[‡] Pål Ulvedal[§] Antoine Lepetit[¶]

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Abstract

In this paper we extend the standard Blanchard-Quah decomposition to enable fluctuations in aggregate demand to have a long-run impact on the productive capacity of the economy through hysteresis effects. These demand shocks are found to be quantitatively important in the US, in particular if the Great Recession is included in the sample. Demand-driven recessions lead to a permanent decline in employment while output per worker is largely unaffected. The negative impact of a permanent decline in investment (including R&D investment) on productivity is compensated by the fact that the least productive workers are disproportionately hit by the shock and exit the labor force.

Keywords: Hysteresis, Structural Vector Autoregressions, Sign restrictions, Long-run restrictions, Productivity

JEL codes: C32, E24, E32

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1 Introduction

Macroeconomists are used to decomposing movements in real economic activity into an upward trend and transitory fluctuations around the trend, interpreted as business cycles. According to this conventional view, the trend is determined by supply-side factors, such as developments in technology and labor supply, while the business cycle is mostly driven by shocks to the components of aggregate demand and monetary policy. This trend-cycle decomposition is embedded in the standard toolkit of modern macroeconomic analysis. On the one hand, dynamic stochastic general equilibrium (DSGE) models imply that demand factors have either no effect at all or only a small transitory effect on the productive capacity of the economy, depending on the parameterization and on the details of the definition of potential output (cf. [Blanchard \(2018b\)](#)). On the other hand, structural vector autoregressions (SVAR) are often estimated imposing the identification scheme used in the seminal paper by [Blanchard and Quah \(1989\)](#), which assumes the presence of one (and only one) shock with potentially permanent effects on output and one (and only one) shock with zero long-run effects on output.¹ The former is traditionally interpreted as a supply shock while the latter is seen as a demand shock. According to [Blanchard \(2018b\)](#), the “independence assumption” that productive capacity is independent of monetary policy, and more generally of demand factors, has become the dominant paradigm in macroeconomics and is the basis of the inflation-targeting framework used by most central banks.

One alternative (and minority) view, popularized by [Blanchard and Summers \(1986\)](#) in the 1980s, states that fluctuations in demand (and large recessions in particular) may have a permanent effect on the productive capacity of the economy through hysteresis effects. Economic developments in Europe in the 1980s seemed to support this view since unemployment was stabilizing at a higher level following every recession. However, the long period of stability referred to as the Great Moderation was interpreted by many economists as supportive of the conventional view, and research on hysteresis largely

¹A clear distinction between shocks with transitory effects driving the business cycle and shocks with long-run effects is supported (without being imposed) also by recent results in [Angeletos, Collard, and Dellas \(2020\)](#).

disappeared. The idea that recessions may have long-run effects has re-emerged in the aftermath of the Great Recession as estimates of potential output have been lowered continuously over several years. [Gordon \(2015\)](#), [Fernald, Stock, Hall, and Watson \(2017\)](#)), [Antolin-Diaz, Drechsel, and Petrella \(2017\)](#) and [Eo and Morley \(2020\)](#)) argue that these revisions mainly reflect lower pre-existing trends in productivity growth and labor supply somewhat masked by the boom in the pre-Great Recession period. In contrast, [Summers \(2014\)](#) interpret them as evidence of hysteresis and stated that “*Any reasonable reader of the data has to recognize that the financial crisis has confirmed the doctrine of hysteresis more strongly than anyone could have anticipated*”.

In this paper, we run a horse-race between the conventional view and the hysteresis view by proposing a simple extension of the SVAR framework proposed by [Blanchard and Quah \(1989\)](#) to allow (without imposing) for hysteresis effects to play a role in economic dynamics. More specifically, we disentangle two shocks (rather than one) with potentially permanent effects on economic activity: a traditional supply shock and a more novel demand shock that are separately identified on the basis of the short-run co-movement between output and prices. The use of data on inflation to disentangle the demand and the supply components of secular stagnation is advocated by [Summers \(2015\)](#). Similarly, we decompose the transitory shock into two components: a demand and a supply shock, both with zero long-run effect on output. In practice, we combine long-run and sign restrictions to identify a SVAR using the state-of-the-art methodology proposed by [Arias, Rubio-Ramirez, and Waggoner \(2018\)](#). We focus our attention on the demand shock with potentially permanent effects on output and we evaluate in detail its importance for economic fluctuations and its transmission mechanism. The more important this shock is, the larger are the deviations from the independence assumption and the larger is the role for hysteresis effects. While everyone will most likely agree that demand shocks and recessions have permanent effects on some individuals, it is debatable whether these effects are sufficiently large to affect secular trends in macroeconomic variables.

Our main result is on *the relevance of hysteresis effects*. We find that demand shocks with potentially permanent effects are important in the US: they explain almost 50 percent of long-run output fluctuations. While not dominant, such a relevant role for demand

shocks in the long-run highlights that the traditional interpretation of the shock with potentially permanent effects as a supply shock is not warranted. Both supply-side and demand-side factors are needed to explain jointly data on output, prices, employment and investment. Somewhat intuitively, hysteresis effects are less important, yet not negligible, if the model is estimated on a shorter sample ending just before the Great Recession.

Our second result relates to *the transmission mechanism of hysteresis effects*. As discussed in [Blanchard \(2018b\)](#), a long-run decline in output can be conveniently decomposed into an effect on employment and an effect on output per worker. We find that the decline in demand propagates almost exclusively through employment. In fact, output per worker, which can be interpreted as a simple measure of labor productivity, is hardly affected at all, both in the short run and in the long run. A permanent decline in employment, accompanied by an increase in unemployment, a decline in participation and an increase in applications (and awards) for disability insurance, reflects standard hysteresis channels compatible with skill depreciation and reduced employability of long-term unemployed workers.² When it comes to the neutral effect on labor productivity, we show that it is the likely outcome of compensating effects.³ On the one hand, we identify a permanent decline in investment (and also in R&D investment) that calls for a decline in productivity. On the other hand, TFP increases and the share of employment in routine ([Jaimovich and Siu \(2020\)](#)), and arguably less productive, tasks decreases in response to a negative demand shock. This larger effect on less productive workers pushes up labor productivity according to a standard composition effect. Our results seem to indicate that these two forces compensate each other, leaving output per worker unaffected by the shock. Notably, while invariant to demand shocks, output per worker responds strongly to a supply shock with potentially permanent effects. Therefore, conditional on accepting output per worker

²The original paper on hysteresis by [Blanchard and Summers \(1986\)](#) and its more modern reinterpretation in the context of the New Keynesian model by [Galí \(2020\)](#) study the long-run effect of demand shocks on unemployment. More recent contributions (cf. [Yagan \(2019\)](#)) focus on the impact on the employment-to-population ratio that has not recovered in the aftermath of the Great Recession, unlike the unemployment rate.

³Several recent papers use New Keynesian models with endogenous growth to examine the hypothesis that the slowdown in productivity following the Great Recession was to a large extent an endogenous response to the collapse in demand that caused the contraction in economic activity. See [Anzoategui, Comin, Gertler, and Martinez \(2019\)](#), [Benigno and Fornaro \(2018\)](#), [Bianchi, Kung, and Morales \(2019\)](#), [Garga and Singh \(2020\)](#), [Guerron-Quintana and Jinnai \(2019\)](#), [Ikeda and Kurozumi \(2019\)](#) and [Moran and Queralto \(2018\)](#).

as a measure of labor productivity, our results are consistent with supply shocks being the only drivers of labor productivity in the long-run, as assumed in [Galí \(1999\)](#).

We contribute to the empirical literature on hysteresis (cf. [Cerra, Fatás, and Saxena \(2020\)](#) for a recent detailed survey). Most studies restrict their attention to deep recessions and investigate their impact on the economy's productive capacity. [Cerra and Saxena \(2008\)](#) find evidence of highly persistent effects on the level of output. Since recessions are not necessarily all driven by demand factors, [Blanchard, Cerutti, and Summers \(2015\)](#) focus on 22 recessions associated with intentional disinflations, mostly concentrated during the 1980s and early 1990s. These recessions are driven by large monetary policy shocks that reflect mainly a change in policy rather than the policy response to other shocks. They find that nearly two-thirds of these recessions are associated with a lower level of output later and that a significant fraction of those is associated with lower growth rates of output. Rather than focusing on recessions in a cross-section of countries, we exploit the time-series dimension for the US and propose the simplest extension to the seminal paper by [Blanchard and Quah \(1989\)](#). As far as we know, our simple extension has not been proposed yet in the literature, despite being advocated informally both by [Blanchard \(2018a\)](#) and [Fatás and Summers \(2016\)](#). Perhaps, the closest paper to ours is [Galí and Hammour \(1992\)](#), who also identify demand shocks with potentially permanent effects and find a positive long-run effect of negative demand shocks on productivity using US data. However, [Galí and Hammour \(1992\)](#) disentangle demand and supply shocks by imposing a zero-impact restriction such that demand shocks cannot have a contemporaneous effect on productivity while we rely on the intuitive sign restriction on the co-movement between output and prices. Notably, sign restrictions have been introduced well after (cf. [Canova and De Nicoló \(2002\)](#), [Faust \(1998\)](#) and [Uhlig \(2005\)](#)) and the combination of sign and zero restrictions has become feasible only with the routines recently developed by [Arias, Rubio-Ramirez, and Waggoner \(2018\)](#). Our paper also connects with studies on unemployment dynamics in Scandinavian countries (cf. [Jacobson, Vredin, and Warne \(1997\)](#)), in Italy ([Gambetti and Pistoiesi \(2004\)](#)) and in Spain ([Dolado and Jimeno \(1997\)](#)), where identification is achieved by imposing several zero long-run restrictions or several stochastic trends. We complement long-run restrictions with sign restrictions. Finally, while we

consider demand shocks with long-run effects on the *level* of output, [Maffei Faccioli \(2020\)](#) studies the impact of demand factors on the *growth rate* of output (an effect named by [Ball \(2014\)](#) as super-hysteresis) in a SVAR with common trends and finds supportive evidence.

The paper proceeds as follows. Section 2 provides a brief description of our empirical set-up. Section 3 presents our main results. Section 4 discusses the channels of hysteresis effects. Section 5 investigates the robustness of our results. Finally, Section 6 concludes.

2 A Simple Extension of Blanchard and Quah (1989)

We consider the standard reduced-form VAR model:

$$y_t = C_B + \sum_{i=1}^P B_i y_{t-i} + u_t, \quad (2.1)$$

where y_t is a $N \times 1$ vector containing our N endogenous variables, C_B is a $N \times 1$ vector of constants, B_i for $i = 1, \dots, P$ are $N \times N$ parameter matrices, with P the number of lags (3 in our specific case), and u_t the vector of residuals with $u_t \sim N(0, \Sigma)$, where Σ is the $N \times N$ variance-covariance matrix. In order to map the economically meaningful structural shocks from the reduced-form estimated shocks, we need to impose restrictions on the estimated variance-covariance matrix. In detail, the prediction error u_t can be written as a linear combination of structural innovations ϵ_t :

$$u_t = A\epsilon_t$$

with $\epsilon_t \sim N(0, I_N)$, where I_N is an $(N \times N)$ identity matrix and where A is a non-singular parameter matrix. The variance-covariance matrix has thus the following structure $\Sigma = AA'$. Our goal is to identify A from the symmetric matrix Σ . We rely on restrictions on the sign of the variables' impact response to shocks and on zero restrictions on the transitory shocks' long-run impact. We estimate our model using Bayesian methods, by specifying normal-inverse-Wishart priors and using the algorithm proposed by [Arias, Rubio-Ramirez, and Waggoner \(2018\)](#) that extends the algorithm by [Rubio-Ramirez, Waggoner, and Zha \(2010\)](#) to integrate appropriately zero restrictions with a set of sign restrictions in a

Bayesian framework. The use of this algorithm is crucial to differentiate our paper from Galí and Hammour (1992), Gambetti and Pistoresi (2004) and Dolado and Jimeno (1997), who rely only on zero restrictions. To set the scene, we replicate in the Appendix the original analysis by Blanchard and Quah (1989) in our framework. We recover their results when using (as they do) data on real GNP growth and (detrended) unemployment over the period 1950:Q2 - 1987:Q4.

We use quarterly US data on real GDP per capita, PCE deflator, employment-to-population ratio and investment per capita over the sample period 1983:Q1-2019:Q4. All variables enter our baseline model in first differences. The use of data in first differences for the employment ratio relates to the debate on the use of data on hours worked (in levels or in first differences) between Galí (1999) and Christiano, Eichenbaum, and Vigfusson (2003) among others. Here, we follow Galí (1999) and use data in first differences in order to allow for (without imposing) hysteresis effects on employment. A specification in levels would tilt the impulse response to converge back to zero, thus making hysteresis effects immaterial (at least in the long run). Nonetheless, we consider this alternative specification in Section 5. We include three lags, four observable variables and four structural shocks. Two shocks are transitory while the remaining two are allowed to have permanent effects.

The identification assumptions are summarized in Table 1. We impose that the two transitory shocks have a zero-long-run impact on output (as in Blanchard and Quah (1989)) and employment, thus implying that labor productivity is not affected in the long run by transitory shocks. While useful to sharpen identification, the long-run restriction on employment is by no means needed for our results to hold. The long-run impact of the remaining shocks is left unrestricted, leaving open the possibility for demand shocks with potentially permanent effects to affect labor productivity and employment in the long run. We disentangle the two transitory shocks on the basis of the short-run co-movement between output growth and inflation: a transitory demand shock moves the two variables in the same direction while a transitory supply shock moves them in the opposite direction. The same restriction on the co-movement between output growth and inflation is also used to disentangle the two shocks with potentially permanent effects. Thus, we identify a supply shock with potentially permanent effects and a more novel

Table 1: Identifying restrictions

	Demand - perm.		Supply -perm.		Demand - temp.		Supply - temp.	
	Impact	Long-run	Impact	Long-run	Impact	Long-run	Impact	Long-run
GDP	-		-		-	0	-	0
PCE deflator	-		+		-		+	
Employment						0		0
Investment								

demand shock with potentially permanent effects, as suggested by [Summers \(2015\)](#). In a standard Blanchard-Quah decomposition, the two shocks are commingled and interpreted as a supply shock despite the fact that no restriction on inflation is imposed. While this paper focuses on the demand shock with potentially permanent effects, we emphasize here that we allow for permanent effects without imposing them ex-ante. The data may very well assign a minor role to the shock ex-post and leave the long-run dynamics explained by the supply shock alone. All sign restrictions are imposed on impact, as recommended in [Canova and Paustian \(2011\)](#).

We remark that data on (detrended) unemployment, rather than on the employment-to-population ratio, are used in the standard Blanchard-Quah decomposition. Our choice is based on the fact that the unemployment rate has recovered (albeit slowly) to its pre-Great Recession level while the employment-to-population ratio has not. Therefore, it seems more fruitful to search for hysteresis effects by looking at employment to population data (cf. [Yagan \(2019\)](#)).

The fourth variable in the system, i.e. investment in the baseline model, is left unrestricted and allows us to investigate the strength of the investment channel emphasized by [Benigno and Fornaro \(2018\)](#).

A word of caution on the identification strategy needs to be added here. It should not be taken for granted that a negative supply shock with potentially permanent effects should lead to an increase in inflation. It is possible to find parameterizations of the standard New Keynesian model under which a negative permanent technology shock leads to a decrease in inflation (cf. [Galí, López-Salido, and Vallés \(2003\)](#) among others). However, the overwhelming majority of estimated New Keynesian models and SVAR models find a positive response of inflation to a contractionary technology shock (cf.

Christiano, Eichenbaum, and Vigfusson (2003), Basu, Fernald, and Kimball (2006), Galí and Rabanal (2004), Paciello (2011) and Altig, Christiano, Eichenbaum, and Linde (2011) among others).

In the literature, hysteresis effects are often associated with recessions and not with booms. We remark, however, that Ball, Mankiw, and Nordhaus (1999) and, more recently, Aaronson, Daly, Wascher, and Wilcox (2019) and Bluedorn and Leigh (2019) provide evidence of positive hysteresis where permanent decreases in unemployment are caused mainly by demand expansions. In light of these results, our model’s linear structure, although admittedly simple, seems to be a reasonable starting point to search for hysteresis effects.

3 Searching for Hysteresis Effects

In this section, we present our results in the context of our baseline model estimated on US data over the sample period 1983:Q1-2019:Q4. Since SVAR models identified with long-run restrictions are sensitive to trend breaks and low-frequency correlations (cf. Fernald (2007)), we have chosen to focus on a relatively homogeneous sample.

In Figure 1, we plot impulse responses to the two shocks with potentially permanent effects for the variables in levels (obtained after cumulating the responses of the variables in first differences). Note that all impulse responses plotted in the paper are in response to negative (contractionary) shocks. Moreover, the solid line represents the posterior median at each horizon and the shaded area indicates the 16th and 84th percentiles obtained from the set of impulse responses consistent with our identification assumptions. In Figure 2, we present the forecast error variance decomposition based on the point-wise median impulse response.

Our main result is that the GDP response to a demand shock is surprisingly similar to its response to a supply shock, also from a quantitative point of view. According to our model, demand shocks have long-run effects and these effects are substantial. While supply shocks are still the main drivers of output, demand shocks explain more than 25 percent of output variation in the short run and almost 50 percent in the medium to

Figure 1: IRFs of the two shocks with potentially permanent effects on output

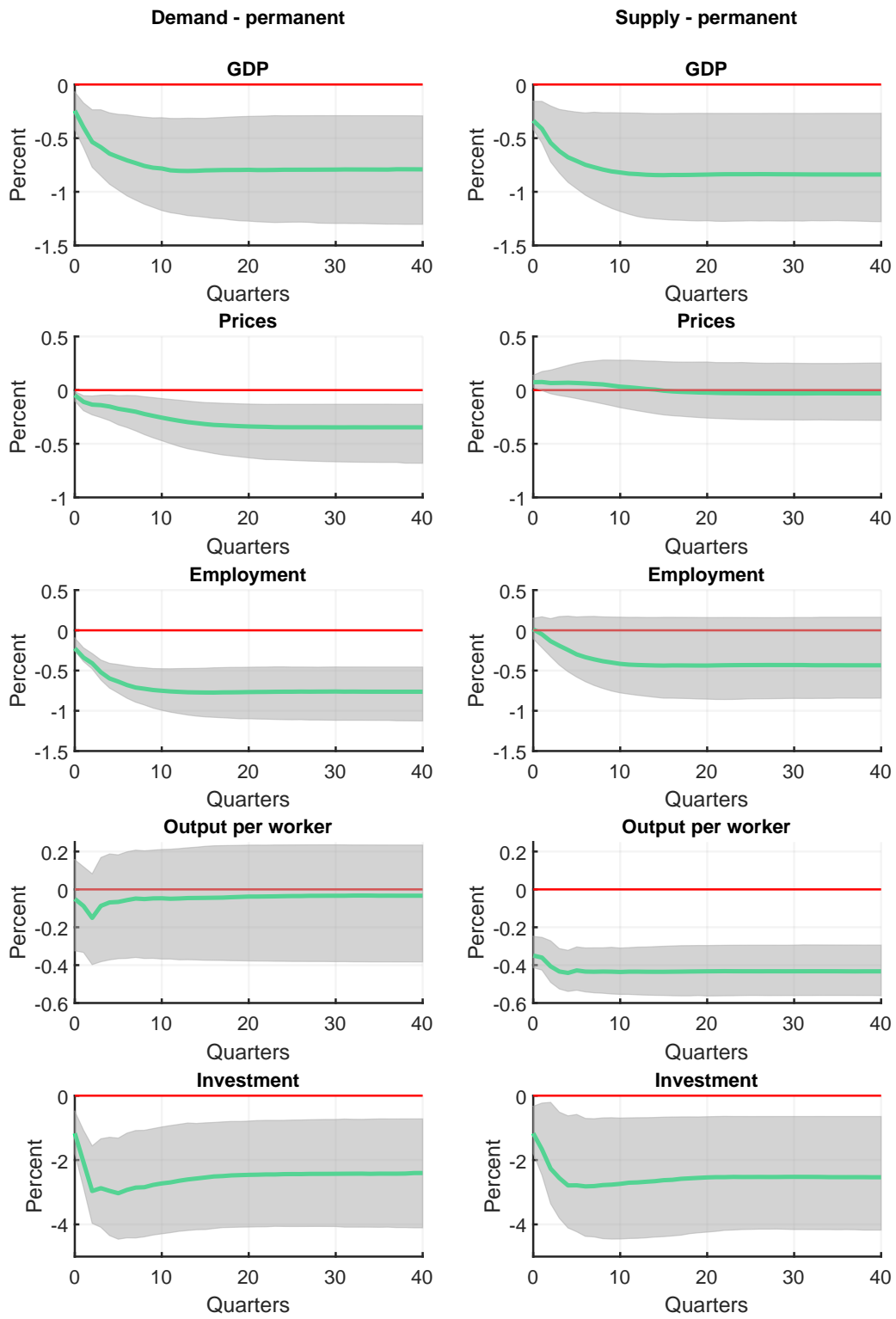
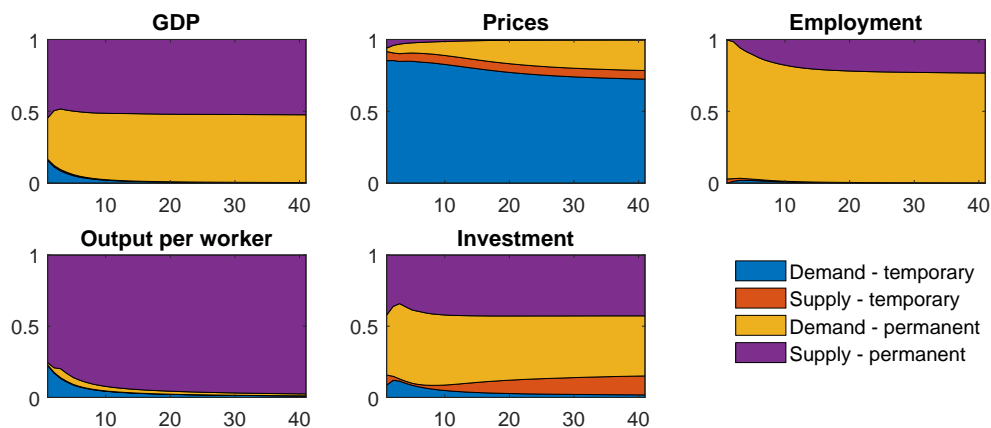


Figure 2: Variance decomposition



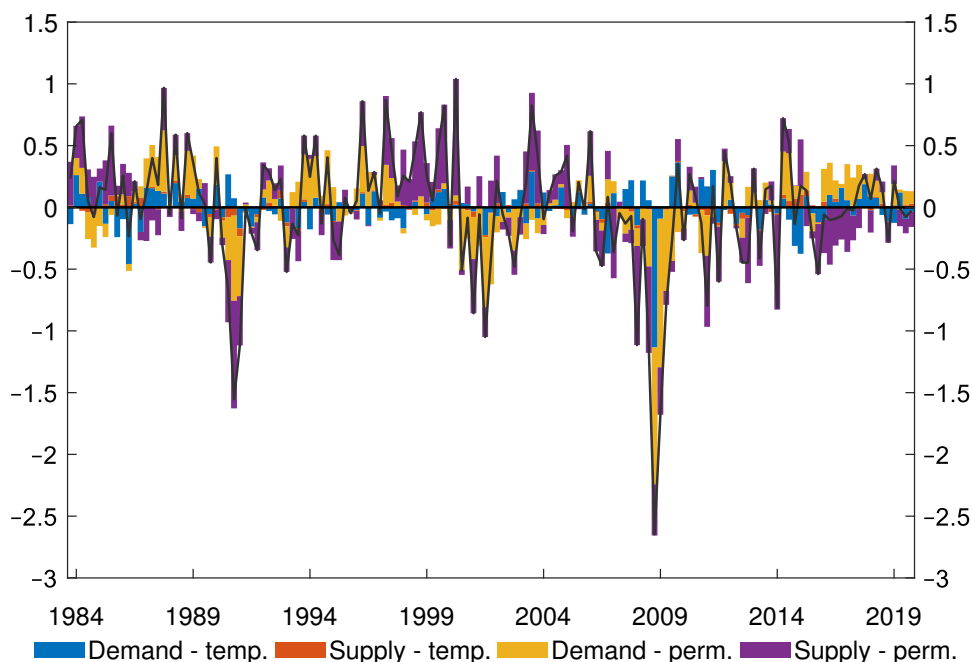
long run. Notably, these similar dynamics are not the result of poorly identified shocks. The dynamics of the price level response to the two shocks are substantially different despite being restricted only on impact. In addition, the decomposition of the output response between employment and output per worker suggested by [Blanchard \(2018b\)](#) reveals clear differences. The demand shock propagates almost only through employment, with the median response of output per worker close to zero over the entire horizon. In contrast, the supply shock propagates mainly through output per worker. Interestingly, output per worker is driven almost only by supply shocks in the long run, a result that is consistent with the identification scheme proposed by [Galí \(1999\)](#) in order to identify technology shocks in a SVAR with only one shock with potentially permanent effects.⁴

Hysteresis effects are large: a negative demand shock leads to a permanent decline in the employment-to-population ratio and demand shocks are the main drivers of employment fluctuations, both at short and long horizons. Sizeable hysteresis effects propagating mainly through the employment-to-population ratio are a defining feature of our results. Investment drops in response to both shocks, in keeping with the channel emphasized by [Benigno and Fornaro \(2018\)](#).

We now briefly comment on transitory shocks that play a limited role. The transitory supply shock is negligible, with the partial exception of its effects on price and investment dynamics. Transitory demand shocks explain less than 20 percent of output fluctuations in

⁴Technology shocks are not necessarily the only supply shocks with potentially permanent effects on output and labor productivity. [Mertens and Ravn \(2011\)](#) find that tax shocks have significant long-run effects on aggregate hours, output and labor productivity.

Figure 3: Historical decomposition of the growth rate in GDP per capita

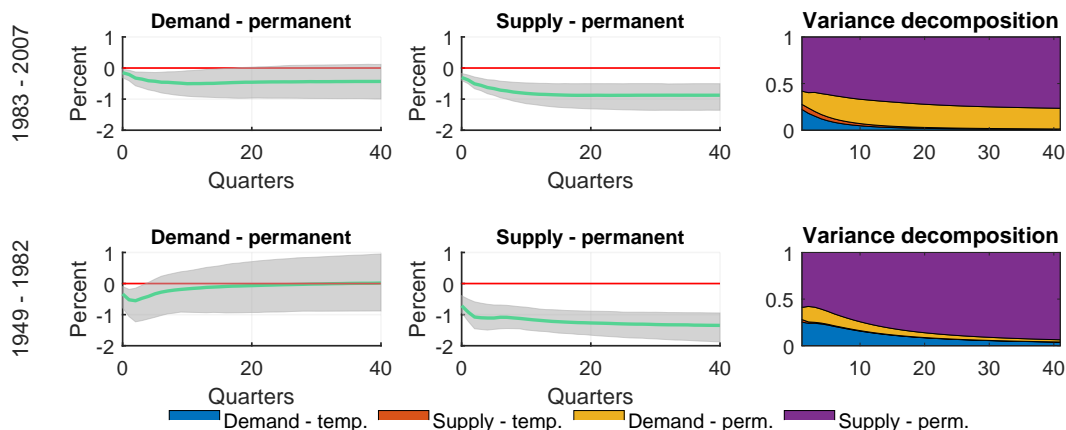


the very short run and a large share of fluctuations in the price level. Unlike in [Blanchard and Quah \(1989\)](#), the limited role of transitory shocks is a robust feature of our baseline model that we investigate further in [Section 5](#). Impulse responses to transitory shocks are presented in the Appendix.

In [Figure 3](#) we present a historical decomposition for output growth (in deviation from its deterministic component) and we note how demand shocks with potentially permanent effects are dominant in recessions. Interestingly, the sustained growth rates in the 1990s are explained by supply shocks, in line with the high productivity growth in that period.

One obvious question of interest is whether the presence of the Great Recession, by far the largest recession in the sample, is driving our results. To check this conjecture, we re-estimate the same model over the sample period 1983:Q1-2007:Q4. As shown in [Figure 4](#), the role of demand shocks with potentially permanent effects is substantially lower in this shorter sample but not negligible. Perhaps not surprisingly, our model seems to suggest particularly strong hysteresis effects associated with the Great Recession. However, evidence of hysteresis effects is present even during the relatively quiet period associated

Figure 4: IRFs and variance decompositions for GDP in alternative samples



with the Great Moderation.

In a second experiment, we estimate our baseline model over the period 1949:Q1 - 1982:Q4, a period in which recoveries were not “jobless”, as discussed in [Jaimovich and Siu \(2020\)](#). We see from Figure 4 that results are substantially different with respect to our baseline sample period (i.e., 1983:Q1-2019:Q4). The Blanchard-Quah assumption of one supply shock with potentially permanent effects co-existing with one demand shock with transitory effects describes the data relatively well. Demand shocks with potentially permanent effects turn out to play a minor role. This result is particularly important because it confirms that hysteresis effects on output (and on employment) are allowed for but not imposed in our set-up. In this specific case, the point-wise median impulse response converges back to zero after 25 quarters (the same is true also for employment), thus showing that the mere presence of demand shocks with permanent effects is not sufficient to guarantee that they have notable explanatory power. Hysteresis effects seem to be present in the US only in the more recent period, which is associated with jobless recoveries.

4 The Channels of Hysteresis Effects

In the previous section, we documented that hysteresis effects propagate almost entirely through employment rather than output per worker. We now investigate further the trans-

mission channels by studying the behavior of other macroeconomic variables in response to demand shocks with potentially permanent effects. We follow [Romer and Romer \(2004\)](#) and [Coibion, Gorodnichenko, and Ulate \(2018\)](#) and regress each macroeconomic variable of interest on current and past values of demand shocks with potentially permanent effects as recovered in our baseline SVAR model, accordingly to the following regression:

$$\Delta y_t = \alpha + \sum_{s=1}^3 \lambda_s \Delta y_{t-s} + \sum_{s=0}^{20} \beta_s S_{t-s} + \varepsilon_t \quad (4.1)$$

where y_t is the macroeconomic variable of interest and S_t represents the time series for the shock identified in the baseline model. We use the autoregressive distributed lag specification to estimate impulse response function (up to horizon 20) as done by [Romer and Romer \(2004\)](#). In some cases, we conduct the same regression to trace the effects of supply shocks with potentially permanent effects for comparison. We follow a Bayesian approach where for each draw of the shock's distribution we compute impulse responses from equation (4.1) using a noninformative normal-Wishart prior on the coefficients. The underlying idea is to calculate the impulse responses of a large set of variables conditional on the distribution of shocks obtained from the baseline SVAR.⁵

4.1 Labor Market Effects

In our baseline model, the employment-to-population ratio is primarily driven by demand shocks with potentially permanent effects. We now consider the response of additional variables to validate our main result and its channels of transmission. In [Figure 5](#) we consider five variables listed by [Blanchard \(2018b\)](#) as the leading candidates to be considered when searching for hysteresis effects. In the left column of [Figure 5](#), we present the responses to demand shocks, while on the right column, we plot the responses to supply shocks in order to highlight the differences in the transmission mechanism and re-confirm that our simple identification strategy seems to be successful at disentangling the two

⁵This Bayesian approach is similar to [Miranda-Agrippino and Ricco \(2020\)](#). However, since we include lagged values of the variables of interest in the regression, as recommended by [Montiel Olea and Plagborg-Møller \(2020\)](#), we do not need to do autocorrelation adjustments to the posterior, which simplifies inference.

shocks.

The first obvious candidate when searching for hysteresis effects is the unemployment rate. Not surprisingly, it increases persistently in response to the demand shock, although a similar response is also observed in response to the supply shock. However, as [Blanchard \(2018b\)](#) noted, if some workers become less employable or discouraged, then the unemployment statistics will fail to capture hysteresis effects fully because many of these workers will drop out of the labor force. Therefore, it is important to consider other labor market variables to trace hysteresis effects more precisely. In the second line of [Figure 5](#), we consider the ratio of long-term unemployment (unemployed for 27 weeks or more) to total unemployment: its response is much more persistent in response to demand shocks and model uncertainty is substantially lower than in response to supply shocks. Differences are more striking when considering the participation rate: we find large and permanent effects in response to demand shocks and no effects (on average) in response to supply shocks. These results confirm that the channels of propagation of hysteresis effects in recent years are substantially different from the ones discussed in the literature from the 1980s ([Blanchard and Summers \(1986\)](#)), like the insiders' role in wage formation and their impact on the unemployment rate. Our results are consistent with studies emphasizing the effects of recessions on morale, skills and employability of long-term unemployed leading to large declines in the participation rate (and in the employment-to-population ratio, as shown in the baseline model).

Finally, we consider applications and acceptances for disability insurance. As [Blanchard \(2018b\)](#) puts it, *“cyclical variations in applications for disability insurance can give information about the loss of morale among workers as a result of the state of the labor market. And once people are accepted and start receiving disability payments, terminations are rare. This implies that, to the extent that recessions lead to increases in disability insurance rolls, they have a hysteretic effect on the labor force”*. Our results are consistent with this reasoning, and while applications and awards respond strongly to demand shocks, they hardly respond at all to supply shocks.

We now consider more disaggregated data on the employment-to-population ratio based on gender and race, building on [Aaronson, Daly, Wascher, and Wilcox \(2019\)](#). In

Figure 5: Effects of demand and supply shocks with potentially permanent effects on labor market variables

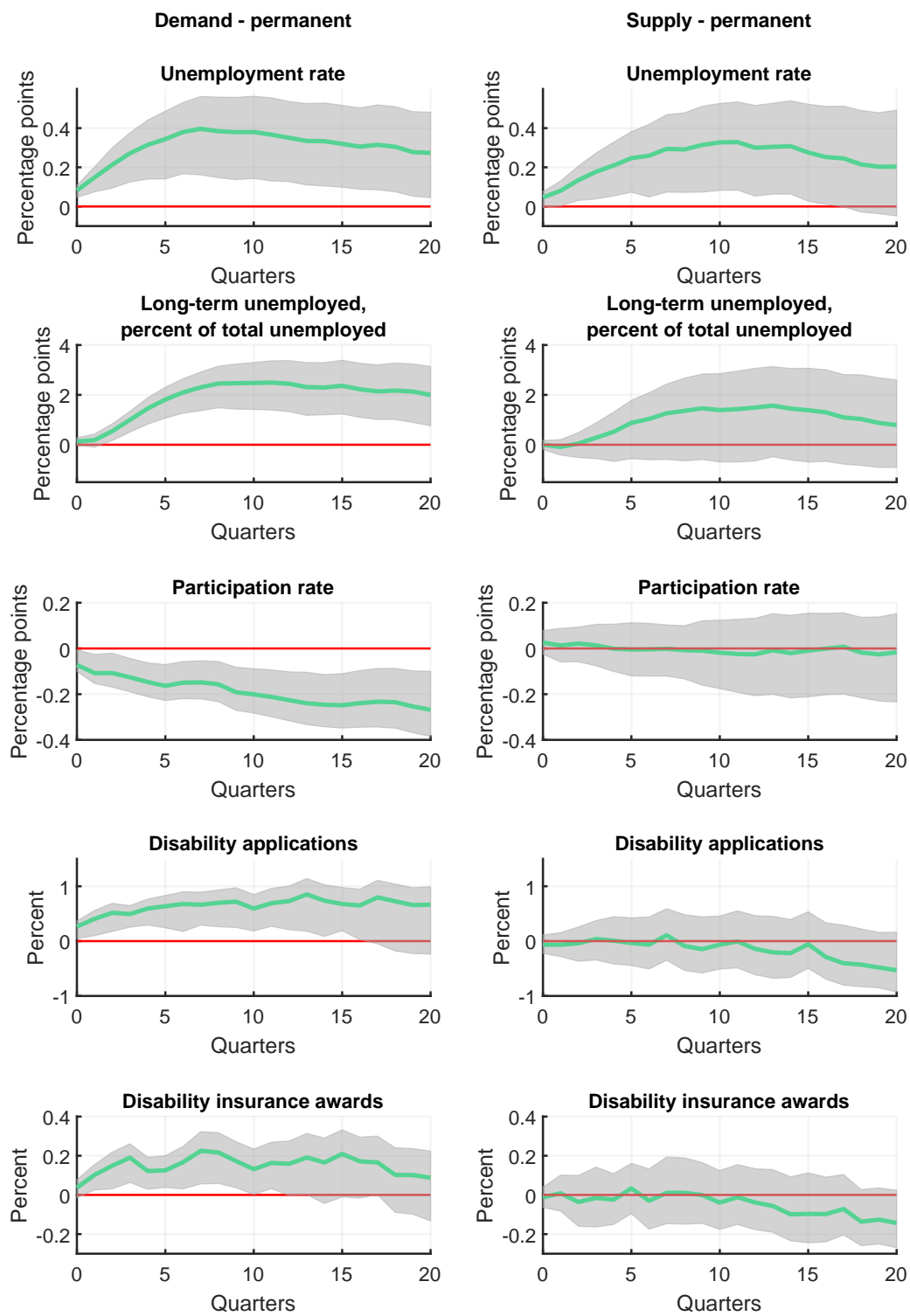


Figure 6: Demand shock with potentially permanent effects: Effects on employment by gender and race

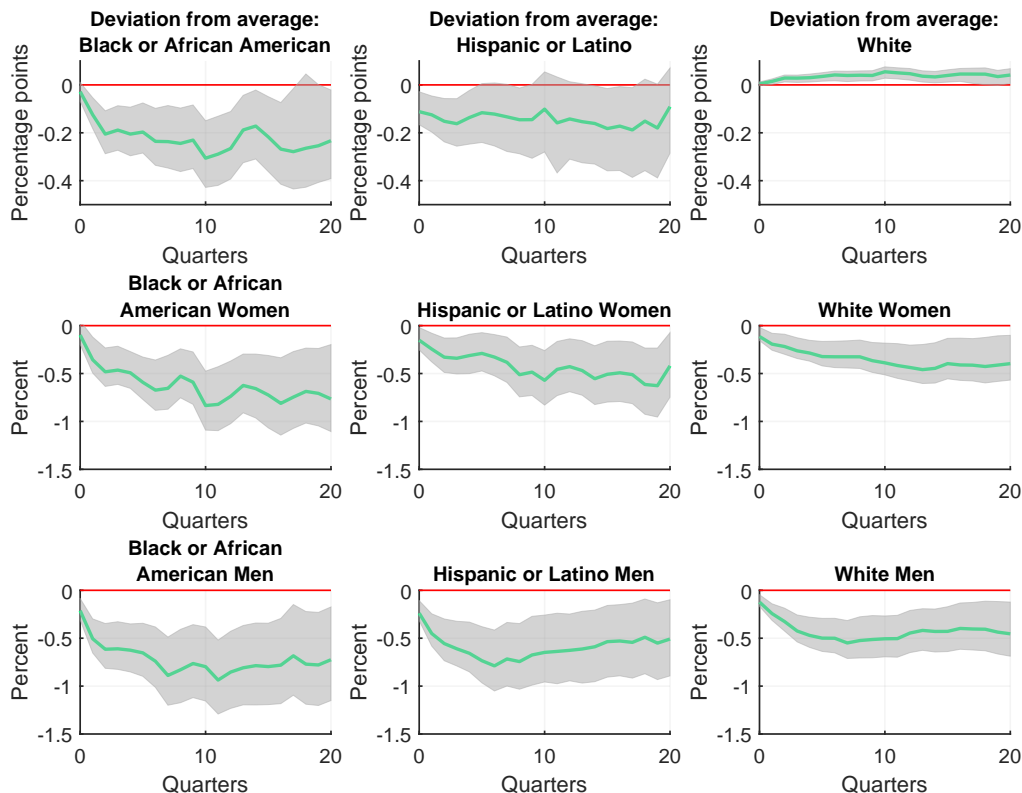


Figure 6, we summarize some selected results in response to demand shocks. In the first row, we plot measures of relative employment for black or African Americans, Hispanic and Latino and white American Men workers. Relative employment is calculated in deviation from the employment-to-population ratio statistic for the whole economy used in our baseline model. We remark that the employment ratio of Hispanic and black American workers is disproportionately affected by the demand shock. We confirm the result in [Aaronson, Daly, Wascher, and Wilcox \(2019\)](#) that recessions (and booms) have particularly strong effects on African Americans in the context of our time series decomposition. In contrast, white Americans suffer a decline in their employment rate that is lower than the average for the entire population.

In the second and third row, we consider the responses disaggregated by gender. We remark that the employment rate for men falls more in the short run for all races, while at the end of the estimation horizon (20 quarters) the effects are similar for men and women.

4.2 Labor Productivity Effects

Strong hysteresis effects on employment are accompanied by almost negligible effects on output per worker in our baseline model. As long as output per worker can be considered a proxy for labor productivity, the reader may notice a tension with the recent literature studying the (potentially) large effects of business cycles on productivity. After all, we find large adverse effects of demand shocks on investment. Why then, does a collapse in investment not translate into a long-run decline in labor productivity? Our results are even more puzzling once we note that R&D investment is also strongly affected by the demand shock (see Figure 7, first row).

One possible explanation is that offsetting factors are at play. To develop our argument, we present in Figure 7 the response of other variables related to productivity, as done above for the labor market. The response of utilization-adjusted TFP, as measured by Fernald (2014), conveys our main message. In fact, it increases in response to a contractionary demand shock while it decreases permanently in response to a contractionary supply shock, thus showing again that the two shocks are set apart. This result is compatible with the view that recessions (that are driven mainly by demand shocks) are periods of intense reallocation in which the least productive workers and units are disproportionately affected. This finding echoes the idea that recessions have a cleansing effect on the productive system, an idea attributed to Schumpeter and Hayek and revived by Caballero and Hammour (1994) and, more recently, by Berger (2018) and Sedláček (2020).⁶ A series of additional impulse responses validate this interpretation. The employment ratio for workers with a bachelor’s degree or higher divided by the average employment ratio increases, meaning that employment for skilled workers declines less than for the other workers in response to demand shocks, while the effect is much less evident in response to supply shocks. In Figure 8, we observe that job reallocation (calculated as the sum of gross job gains rate and gross job losses rate in a quarter) increases in response to a negative

⁶Gali and Hammour (1992) also find that a negative demand shock (identified using a recursive order) leads to an increase in TFP over the period 1947-1989. Interestingly, according to the evidence provided in Figure 4, hysteresis effects were more difficult to detect in that sample. Gali and Hammour (1992) also correctly emphasize that the notion that negative demand shocks with potentially permanent effects are beneficial for productivity does not necessarily imply that “recessions are desirable”.

Figure 7: Effects of demand and supply shocks with potentially permanent effects on variables related to productivity

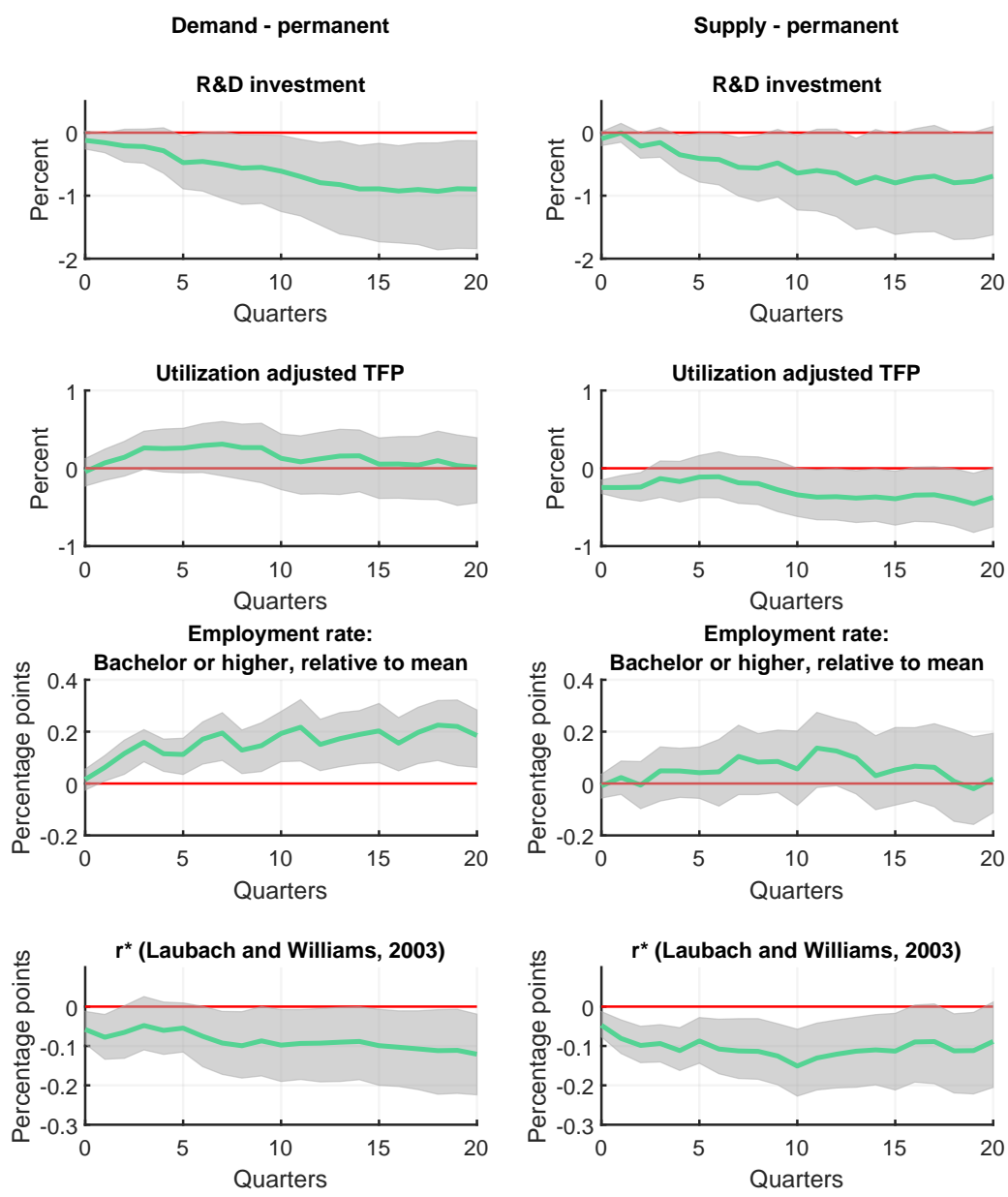


Figure 8: Demand shock with potentially permanent effects: Effects on variables related to the composition of the labor force



demand shock, although only in the short run. In addition, the measure of labor quality computed by [Fernald \(2014\)](#) increases substantially, reflecting the fact that workers with lower skills and education are more likely to lose their jobs. Finally we consider the routine employment share, defined as the ratio of employed workers performing routine tasks (as classified in [Jaimovich and Siu \(2020\)](#)) over total employment. Demand shocks with potentially permanent effects affect disproportionately (and persistently) workers performing routine tasks, in keeping with the fact that job polarization takes place mainly in recessions and generates jobless recoveries, as shown by [Jaimovich and Siu \(2020\)](#).

It is reasonable to think that similar composition effects are at play also on the firm side, causing less efficient production units to become unprofitable and shut down. Our evidence is admittedly weaker in this dimension. However, one fact that is consistent with this narrative is the large and permanent effect of a negative demand shock on employment in the construction sector (expressed as a share of total employment). Productivity in the construction sector is notoriously low and thus a shrinking level of economic activity in that sector will lead to an improvement in aggregate productivity.

All in all, our results hint that two opposing effects may explain the absence of an aggregate effect of negative demand shocks on output per worker. On the one hand, large

declines in investment and R&D investment may depress capital accumulation and lead to lower productivity. On the other hand, selection effects leading workers with lower skills and education to be disproportionately affected may increase labor productivity, thus explaining the neutral effect on the aggregate. Similar mechanisms have been uncovered by [Bhattarai, Schwartzman, and Yang \(2019\)](#) for both employment and labor productivity in a county-level analysis.

A final experiment of obvious policy relevance is to evaluate the effects of our identified shocks with long-run effects on a measure of the natural rate of interest computed as in [Laubach and Williams \(2003\)](#). In the last row of [Figure 7](#), we see that the supply shock has a larger impact in the short to medium run while in the long run both demand and supply shocks (that have a very similar impact on GDP) have a comparable and sizeable impact on the natural rate of interest.

5 Robustness

In this Section, we investigate the robustness of our results along several dimensions.

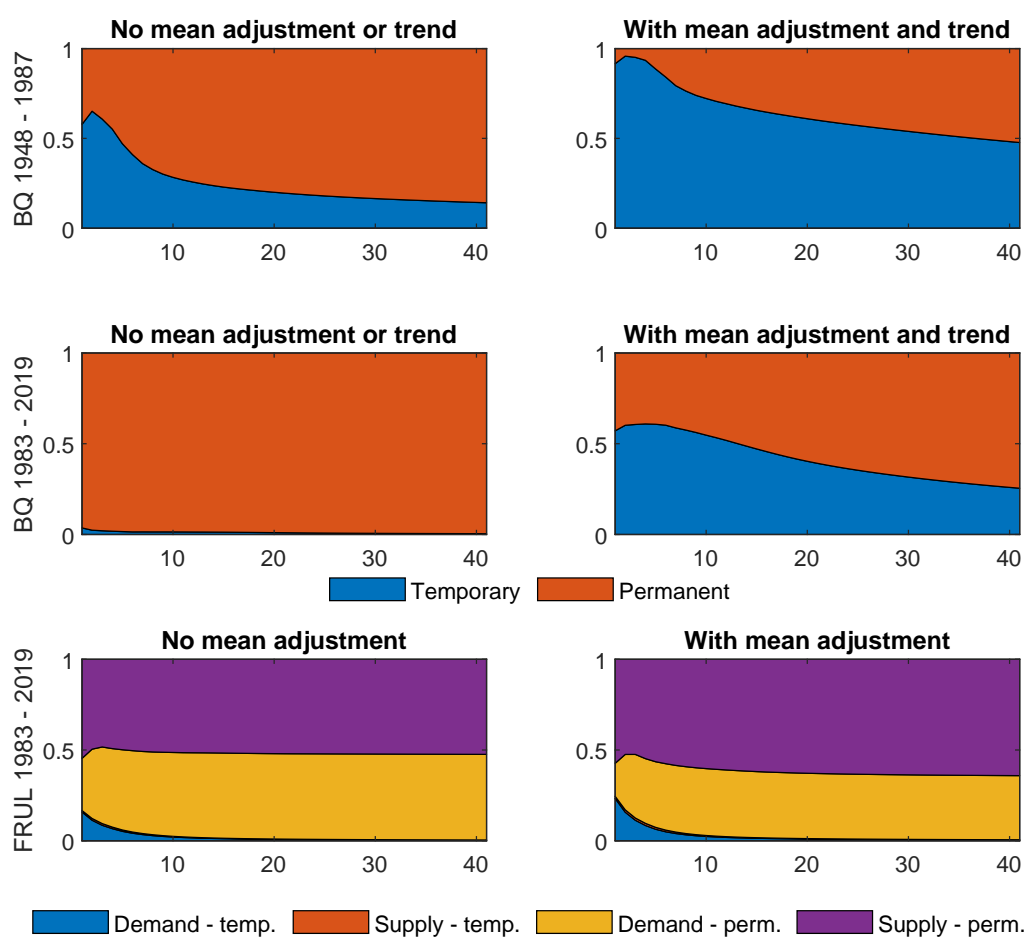
Variance decomposition stability. As shown by [Fernald \(2007\)](#), SVAR models identified with long-run restrictions are sensitive to trend breaks and low-frequency correlations. This instability is discussed also in the original paper by [Blanchard and Quah \(1989\)](#), where the share of the variance explained by transitory disturbances ranges from 40 to over 95 percent at a forecast horizon of four quarters, depending on how structural breaks or slow-moving trends are treated, as shown in the first row of [Figure 9](#) which replicates [Tables 2 and 2C](#) in the original paper. In the left panel, we do not make any adjustments to the series. In the right panel, we detrend the unemployment series and we impose a break in 1973:Q4 and demean the output growth series in the two sub-samples, as in [Blanchard and Quah \(1989\)](#). We remark that the transitory shocks' dominant role in the short to medium run only emerges when the series are adjusted. In the second row, we estimate the same two versions of the Blanchard-Quah model over our sample period (1983-2019): once again, in the left panel, we do not adjust the series, while in the right panel, we detrend unemployment and we impose a break in 2008:Q4 (when output

growth slows down significantly) and demean the output growth series in the two subsamples. Transitory shocks play a minor role in the first case while they explain more than 50 percent of short-run output fluctuations in the second case. We further investigate whether our SVAR model suffers the same kind of instability. In the third row of Figure 9, we present the output variance decomposition in our baseline model (estimated on our sample period) with no adjustment in the left column and with all series demeaned (again with a break imposed in 2008:Q4) in the right column.⁷ Notably, the mean adjustment has only marginal effects on the results with a slightly larger role for transitory and permanent supply shocks. Put simply, it seems that the use of data on employment and investment (and a more detailed identification scheme) make our baseline SVAR more robust to structural breaks.

Role of transitory shocks. Having shown that the limited role of transitory shocks in our baseline model does not depend on the auxiliary assumptions made by Blanchard and Quah (1989), it remains to be checked whether transitory shocks may play a more important role in previous periods of recent US economic history. To investigate this point, we estimate our baseline model recursively over a 120-quarter rolling window and compute the forecast error variance decomposition of output for each sample period. The left column of Figure 10 shows the share of the variance in output and employment explained by the two transitory shocks after four quarters. Each point in the blue lines corresponds to the share of the variance obtained in a model estimated over the previous 30 years. Transitory shocks play an important role in models estimated over the period 1960-1990 and the next ten years while they matter less in recent years. A minor role for transitory shocks is consistent with models featuring endogenous growth where all shocks have permanent effects. The right column of Figure 10 shows the share of variation in output and employment explained by the demand shock with permanent effects after 40 quarters. This shock does not seem to play a relevant role in the beginning of the sample and it becomes important for output (and more so for employment) only in the second

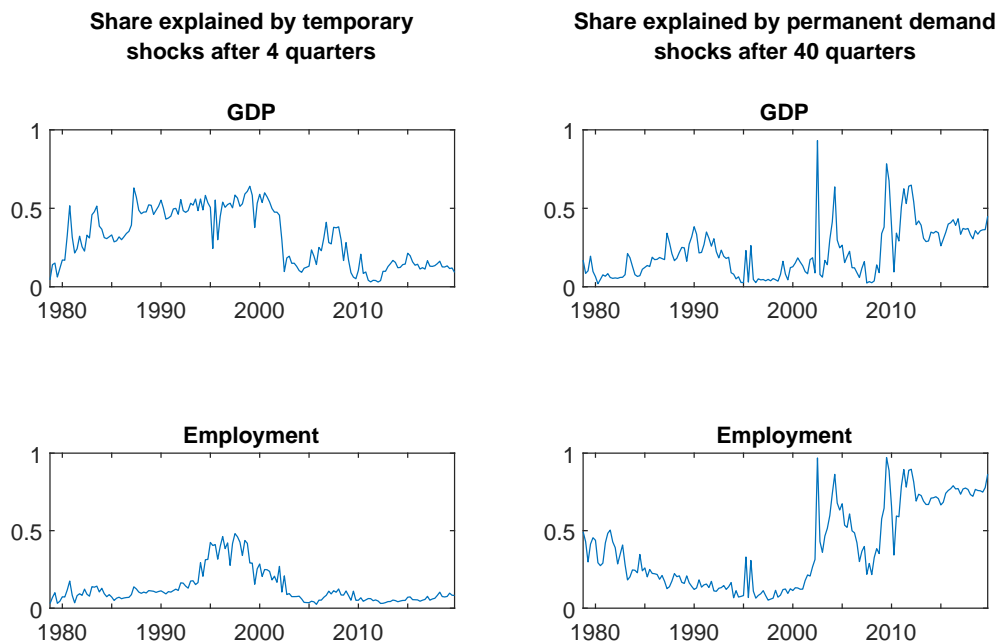
⁷Note that the employment-to-population ratio enters our model in first differences, unlike the unemployment rate in Blanchard and Quah (1989). This implies that we do not need to de-trend it to remove its low frequency component. We estimate a version of the model with employment in levels in the remainder of this Section.

Figure 9: Variance decompositions of GDP in different models and samples



part of the sample, thus confirming the critical role of the Great Recession period in driving our results.

Figure 10: Rolling window estimation (120 quarter window)



Employment data in levels. In our baseline model, we include the employment-to-population ratio in first differences. If we include the employment-to-population ratio in levels, all shocks will have a transitory effect on employment as long as the system is stationary. When we perform this experiment, as shown in Figure 11, demand (or supply) shocks have no permanent effect on employment. However, the effect of the demand shock with potentially permanent effects is quite persistent, also for employment. And even in this case, the shock explains a significant share of the variation of output at a 40 quarter horizon.

No impact restrictions. We estimate a version of the model in which all sign restrictions are imposed at horizon four rather than on impact. In fact, it is conceivable that the bulk of the inflation response may be delayed (and not on impact) in the presence of pervasive nominal rigidities. We see from the first row in Figure 12 that the role of demand shocks with potentially permanent effects is slightly reinforced in this specification.

Shocks to the relative price of investment. Finally, we consider the role of shocks to the relative price of investment. One may wonder whether investment shocks are com-

Figure 11: Model estimated with employment-to-population ratio in levels

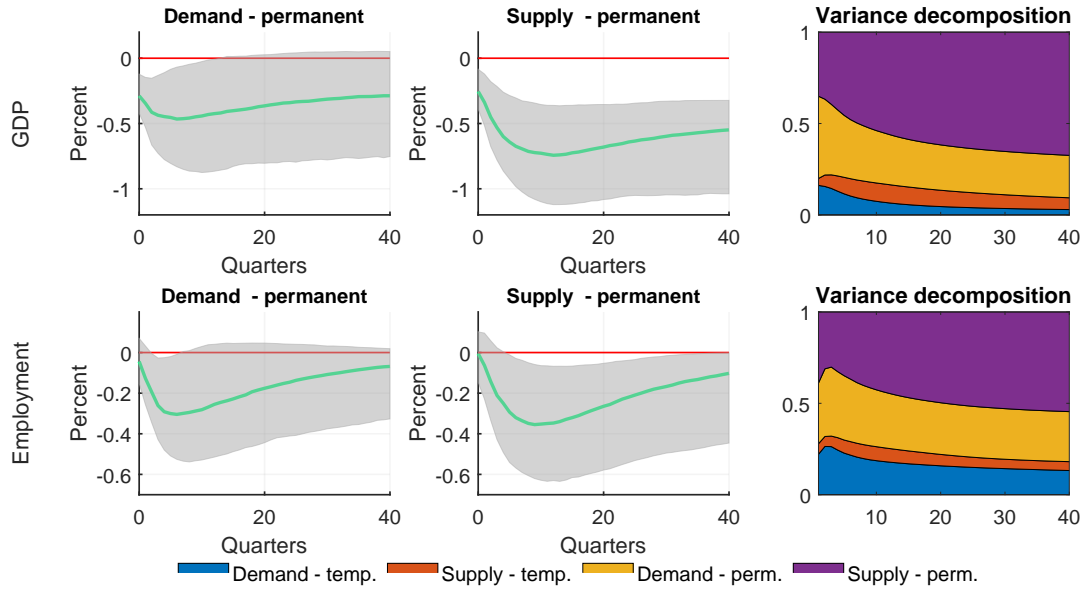
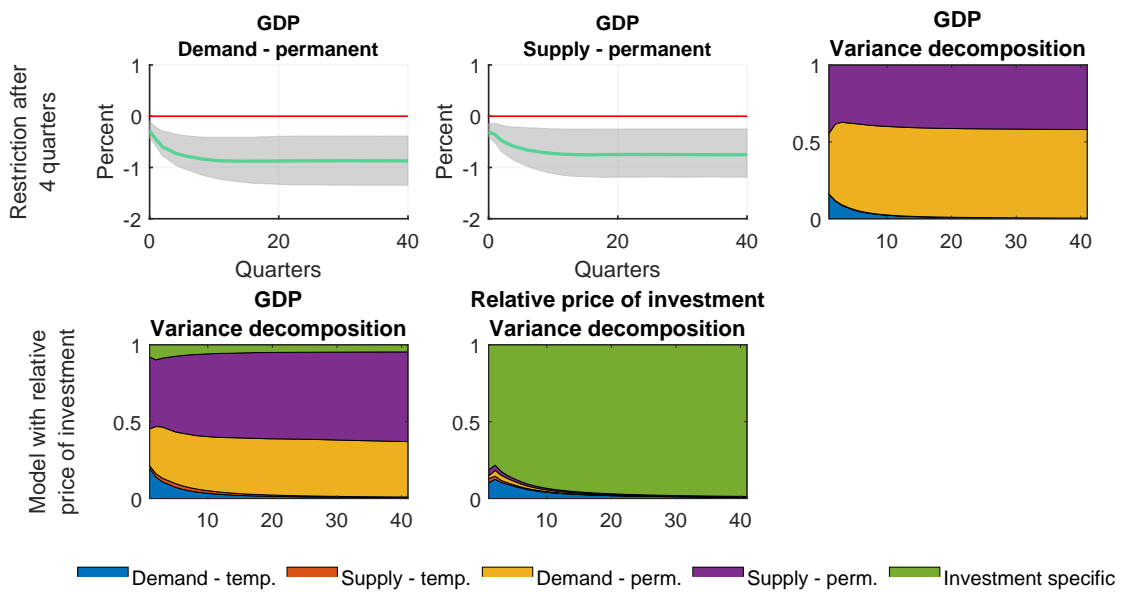


Figure 12: Model with sign restrictions imposed at horizon 4 and model with the relative price of investment as observable



mingled with demand shocks with potentially permanent effects in our baseline model. Therefore, we estimate one extended version of the model including data on the relative price of investment. Following [Fisher \(2006\)](#), the investment shock is identified as the only shock having a long-run effect on the relative price of investment. We also impose the innocuous assumption that the shock generates a negative co-movement between output (and investment) and the relative price of investment as a normalization. The results are presented in the second row in [Figure 12](#). Investment shocks play a limited role in the model (except obviously for the relative price of investment) and demand shocks with potentially permanent effects retain an important explanatory power.

6 Conclusion

In this paper we have re-evaluated the “conventional view” in macroeconomics that output fluctuations can be decomposed into a trend, driven by supply-side factors, and transitory fluctuations around the trend, driven by demand shocks. Using a simple extension of the Blanchard-Quah decomposition, we have shown that two shocks have long-run effects: a traditional supply shock and a more novel demand shock generating hysteresis effects. Therefore, recessions (and booms) driven by demand factors have permanent effects on the economy’s productive capacity. We show that demand factors explain a significant share of the decline in the employment-to-population ratio in the aftermath of the Great Recession. Hysteresis effects transmit through employment and investment but not through output per worker because the least productive workers (and arguably also the least productive firms) are affected disproportionately. While our paper is purely empirical and does not provide normative implications, we believe it is important to have sound empirical evidence on the relevance of hysteresis effects to inform the policy discussion (cf. [Galí \(2020\)](#) and [Garga and Singh \(2020\)](#)).

It is important to stress that our simple analysis is only a first step towards estimating hysteresis effects. As shown by [Benigno, Ricci, and Surico \(2015\)](#), non-linearities are potentially important to study unemployment, productivity and their drivers. Introducing non-linearities in our set-up is certainly promising and desirable, although far from trivial

insofar as the literature has not reached a consensus on how to integrate sign restrictions into non-linear models.

Another avenue for future research consists in disentangling further the origin of hysteresis effects. [Bianchi, Kung, and Morales \(2019\)](#) and [Guerron-Quintana and Jinai \(2019\)](#) find an important role for shocks related to investment (shocks to the marginal efficiency of investment and liquidity shocks, respectively) while supporting evidence on the long-run effects of monetary and fiscal shocks is provided in [Jordà, Singh, and Taylor \(2020\)](#) and [Fatás and Summers \(2018\)](#). All these shocks are bundled together in our analysis and disentangling the different components would be worthwhile at the cost, however, of compromising our baseline model's simplicity.

Finally, we cannot rule out that at least part of our estimated hysteresis effects reflect lower optimism about the future, perhaps capturing the response to downward revisions in forecast potential output growth as hinted in [Blanchard, L'Huillier, and Lorenzoni \(2017\)](#), rather than the legacies of the past. [Blanchard, L'Huillier, and Lorenzoni \(2013\)](#) explore the idea that short-run fluctuations may be partly due to news about the future and discuss the limitations of SVAR models to capture these effects. Disentangling the two narratives is an important topic for future research but outside the scope of our simple analysis.

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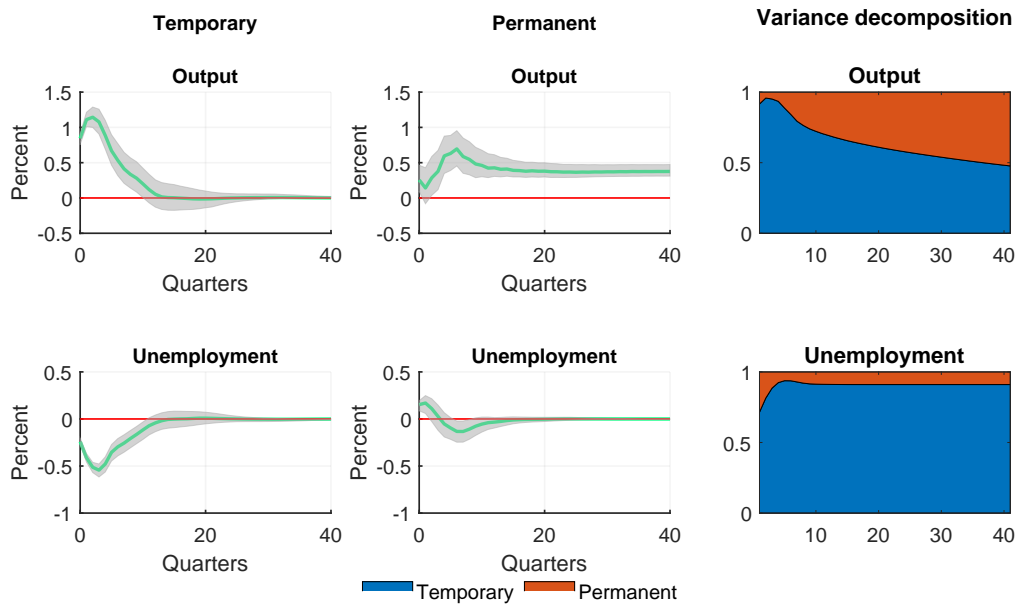
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Figure A-1: Replication of Blanchard and Quah



Appendix

In Figure A-1 we replicate the results in Blanchard and Quah (1989), using the algorithm proposed by Arias, Rubio-Ramirez, and Waggoner (2018) in terms of impulse responses and variance decompositions. Figure A-2 presents impulse responses to the two transitory shocks in our baseline model.

Figure A-2: IRFs of demand and supply shocks with transitory effects

