Fiscal Policy and Occupational Employment Dynamics*

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Abstract

We document substantial heterogeneity in occupational employment dynamics in response to government spending shocks in the United States. Employment rises most strongly in service, sales, and office ("pink-collar") occupations. By contrast, employment in blue-collar occupations is hardly affected by fiscal policy. We provide evidence that occupation-specific changes in labor demand are key for understanding these findings. We develop a business-cycle model that explains the heterogeneous occupational employment dynamics as a consequence of composition effects due to heterogeneous employment changes across industries and occupation-specific within-industry employment shifts due to differences in the short-run substitutability between labor and capital services across occupations.

Keywords: Fiscal Policy, Composition of Employment, Occupations, Industries, Heterogeneity

JEL classification: E62, E24, J21, J23

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1 Introduction

A recurring question in macroeconomics is how fiscal policy affects the economy. An extensive empirical literature examines the impact on macroeconomic aggregates like output, consumption, and employment (e.g., Blanchard and Perotti, 2002, Pappa, 2009, Ramey, 2011a, 2011b) and most theoretical studies rely on the representative agent paradigm (e.g., Baxter and King, 1993, Linnemann and Schabert, 2003). However, important aspects of fiscal policy require taking into account heterogeneity explicitly. First, the distributional consequences of a policy are interesting from a political and societal perspective, e.g., because they affect the welfare assessment of the policy and determine public support for it. Second, distributional aspects can also be key for understanding fully the aggregate effects of fiscal policy. Against this background, the literature is showing substantial interest in the disaggregated effects of fiscal policy.[1]

To assess the effects of fiscal policy on an individual, it is important to understand how fiscal policy affects the individual's employment possibilities, as labor income is the most important income component for most households. An individual's employment possibilities are to a large degree determined by the labor-market situation in the individual's industry and occupation. In related contexts, Artuç and McLaren (2015) have shown that an individual's industry (i.e., the business activity of the employer) is important in determining whether the individual is harmed by international trade while the individual's occupation (i.e., the type of work or job of the individual) is the main factor behind the risk of employment loss due to offshoring. In a short-run context closely related to our study on fiscal policy effects, Jaimovich and Siu (2012) and Hershbein and Kahn (2016) show that both industries and occupations are important determinants of the risk of cyclical job losses. Hence, an important aspect of fiscal stimulus is whether and how strongly it affects employment across industries and occupations. While there exists some evidence on the distribution across industries of the jobs created by fiscal policy (see Chodorow-Reich, Feiveson, Liscow, and Woolston, 2012, Giavazzi and McMahon, 2012, Nekarda and Ramey, 2011, and Wilson, 2012), to our knowledge, little is known about their distribution across *occupations*. This paper

[1] For empirical analyses see, e.g., Anderson, Inoue, and Rossi (2016), Cloyne and Surico (2017), De Giorgi and Gambetti (2012), Giavazzi and McMahon (2012), Johnson, Parker, and Souleles (2006), Misra and Surico (2014), and Nekarda and Ramey (2011). Theoretical analyses on fiscal policy and heterogeneity are provided by, among others, Brinca, Holter, Krusell, and Malafry (2016), Galí, López-Salido, and Vallés (2007), Heathcote (2005), Kaplan and Violante (2014), McKay and Reis (2016), and Oh and Reis (2012).

fills this gap by investigating the occupation dimension of the employment dynamics induced by fiscal policy.

Considering occupations is important because the costs of switching occupation are estimated to be as high as several annual earnings for switches between major occupation groups (see Artuç and McLaren, 2015, and Cortes and Gallipoli, 2017). In particular, the returns to occupational tenure are found to be almost as large as the total returns to labor-market experience and to exceed the returns to firm or industry tenure, see, e.g., Shaw (1984), Kambourov and Manovskii (2009), and Sullivan (2010). These returns would have to be given up upon an occupation switch. For instance, Kambourov and Manovskii (2009) find that a displaced worker switching occupation suffers an 18% reduction in weekly earnings, whereas for a displaced worker whose next job is in the same occupation the drop is only 6%. Hence, even if fiscal policy fosters employment growth in a worker's industry, the worker does not necessarily benefit strongly if job growth is concentrated in other occupations within the industry. The distribution across occupations of the employment effects of fiscal policy is therefore important for understanding the distributional consequences of fiscal policy and its overall effects.

To analyze how fiscal policy affects employment in different occupation groups, we include occupational employment data from the U.S. Current Population Survey (CPS) into otherwise standard expectations-augmented vector-autoregressive models (VARs). We focus on a classical fiscal-policy scenario: an unexpected increase in government spending. As our benchmark, we identify unanticipated government spending shocks through short-run restrictions on the automatic response of government spending to economic activity, taking into account possible anticipation effects due to fiscal foresight that are found to be important by Ramey (2011b). We account for anticipation by incorporating a fiscal news variable in the VARs. Specifically, we use spending forecasts of professional forecasters, following, e.g., Auerbach and Gorodnichenko (2012b).

We find important differences in occupational employment dynamics in response to government spending shocks. Our main result is that employment rises disproportionately in service, sales, and office – so called "pink-collar" – occupations while there are no discernible employment changes for production, construction, transport, and installation ("blue-collar") occupations. We confirm this finding in a series of robustness checks including different identification schemes, detrending methods, and sample periods. The response in management and professional ("white-collar") occupations lies in between the other two groups, i.e., white-collar employment tends to increase but not as strongly and significantly as does pink-collar employment. Quantitatively, our baseline results imply that, over the first year, about two thirds of the additional job-years due to a government spending expansion accrue in pink-collar occupations and only about 10% in blue-collar occupations.

Having documented that a fiscal stimulus strongly and systematically increases pink-collar employment relative to blue-collar employment, we turn to exploring the reasons for this consequence of fiscal policy. We document that hours and wage rates in pink-collar occupations rise relative to those in blue-collar occupations in response to government spending expansions. This co-movement between relative occupational employment and relative occupational wage rates shows that labor-demand forces shape differences in occupational employment dynamics. We provide evidence that the documented heterogeneity in occupational employment dynamics can be explained by two effects. First, there is a between-industry effect, i.e., employment rises disproportionately in industries employing pink-collar occupations disproportionately, which leads to a composition effect in aggregate labor demand favoring pink-collar labor. Second, there is a within-industry effect, i.e., the share of pink-collar work increases within industries. Quantitatively, we show that both effects are about equally important for the documented employment shift away from blue-collar occupations and toward pink-collar occupations.

To understand why firms expand their demand for pink-collar labor more strongly than their demand for blue-collar labor in response to an increase in government spending, we embed occupational labor into a two-industry New Keynesian business-cycle model. To explain the within-industry shift toward pink-collar labor we allow for differences in the short-run substitutability between labor and capital services across occupations (similar to Autor and Dorn, 2013). Our model replicates our empirical findings for a calibration where blue-collar labor is the closer substitute to capital services in the short run than is pink-collar labor. This difference in the elasticity of substitution with capital services reflects the typical tasks in the different occupation groups. Labor in blue-collar occupations includes mainly routine-manual tasks (Jaimovich and Siu, 2012, Foote and Ryan, 2014) which can in principle also be performed by machines. Accordingly, capital services and blue-collar labor are, on average, relatively close substitutes. By contrast, labor in pink-collar occupations involves a substantial share of direct human interaction that is difficult to provide by machines. Thus, capital services are a relatively poor substitute for pink-collar labor. Together with a relatively inelastic supply of labor compared to capital services, this implies that expansionary fiscal shocks induce pink-collar employment booms, i.e., that firms raise their demand for pink-collar labor by more than their demand for blue-collar labor.

The intuition is as follows. Government spending expansions induce firms to demand more factor inputs to meet increased product demand. In this process, firms raise their demand for capital services by more than their demand for labor due to changes in relative factor costs in favor of capital use compared to labor (the latter being a consequence of the less elastic supply of labor compared to capital services). The more intense use of capital lowers the marginal productivity of blue-collar labor relative to pink-collar labor because blue-collar labor is the closer substitute to capital services. Thus, the relative demand for pink-collar labor increases which leads to a rise in the pink-collar to blue-collar employment and wage ratio, in line with what we find in the data.

Our two-industry model also captures the between-industry effect when we allow for heterogeneity in factor intensities across industries and when the pink-collar intensive industry is more strongly affected by government demand, in line with the data. Quantitatively, the model with both between-industry and within-industry effects explains about 75% of the estimated increase in relative pink-collar employment. Disentangling their relative importance, the model assigns about equal shares to between-industry and within-industry effects, in line with what we find in the data.

Our results are remarkable in light of other heterogeneous patterns in occupational employment that have been discussed in the literature. It is well known that blue-collar workers suffer the most from job losses due to technical change and globalization (see, e.g., Acemoglu and Autor, 2011). It has also been shown that blue-collar job losses appear to happen foremost in economic downturns (e.g., Jaimovich and Siu, 2012, and Hershbein and Kahn, 2016) and that blue-collar workers are generally hit hardest by cyclical fluctuations (see, e.g., Hoynes, Miller, and Schaller, 2012). Our results show that the same group of workers benefit the least from employment growth induced by a fiscal stimulus. This suggests that countercyclical fiscal policy contributes to the accelerated relative decline of blue-collar employment in recessions.

The remainder of this paper is organized as follows. In Section 2, we discuss the occupational employment data and our empirical strategy. In Section 3, we present empirical results on occupational employment dynamics. In Section 4, we investigate empirically what lies behind the heterogeneous employment effects of fiscal policy. In Section 5, we develop a theoretical model that can explain our empirical findings. Section 6 discusses implications of our results and concludes.

2 Data and econometric method

In this section, we describe the occupational employment data and present our econometric approach for estimating the effects of government spending shocks on labor-market outcomes by occupation.

2.1 Occupational employment data

We construct quarterly data on aggregate employment and on occupational employment using the Current Population Survey (CPS). This data is available from 1983Q1 and our sample ends in 2015Q4. The U.S. Census Bureau provides conversion factors to adjust for re-classifications of the occupation and industry codes in the CPS, see Shim and Yang (2016) for details. We use these conversion factors to construct consistent time series of employment in ten major occupation groups according to the 2002 Census classification, which we aggregate to three broader occupation groups. The first group are high-skill or white-collar occupations and include management, business, and financial occupations as well as professional and related occupations. The second group are traditional blue-collar occupations and include construction and extraction occupations, installation, maintenance, and repair occupations, production occupations, as well as transportation and material moving occupations. The third group include service occupations, sales and related occupations, as well as office and administrative support occupations (service, sales, and office occupations). Service occupations such as nursing aides, waiters and waitresses, and childcare workers are the largest subgroup in this group while sales occupations are the smallest. Due to the traditional high share of female workers in service, sales, and office occupations and to distinguish them from white-collar and blue-collar occupations, these occupations are sometimes referred to as "pink-collar" occupations, see, e.g., Lee and Wolpin (2006) and Gemici and Wiswall (2014). In our sample, 61% of employed workers in service, sales, and office occupations are women, but only 16% of blue-collar workers. In the following, we borrow the term "pink-collar" occupations as a concise label for service, sales, and office occupations. Note that the results for the broad groups of white, blue, and pink-collar occupations are not driven by specific subcategories of these groups. Our results show that the subcategories of the pink-collar occupation group display employment dynamics in response to fiscal stimulus which are similar to one another. Also the subcategories within the blue-collar occupation group display similar employment dynamics to one another but are distinctly different from pink-collar employment dynamics.[2]

We begin with describing some properties of the occupational employment data that will be important for our subsequent analysis and the interpretation of our results. White-collar, blue-collar, and pink-collar occupations differ in a number of dimensions. Over our sample period, workers in white-collar occupations represent on average about 34% of total employment while the shares are 24% and 42% for workers in blue-collar and pink-collar occupations, respectively. These shares are not constant over our sample period due to differences in trend growth across occupations, see Figure A1 in Appendix B which shows the time series of employment in our three occupation groups. White-collar employment grows disproportionately with an average sample growth rate of around 0.5 percent per quarter, relative to 0.27 percent growth of aggregate employment. Also pink-collar employment rises and shows a quarterly growth rate of 0.22 percent on average. Blue-collar employment, however, remains almost constant such that the share of blue-collar employment in total employment exhibits a downward trend. This heterogeneity in long-run employment dynamics is well documented in the literature and referred to as job polarization, see, e.g., Autor and Dorn (2013).[3] In our econometric analysis focusing on short-run effects, we control for employment trends and consider different ways of handling trends in the data.

Besides differences in long-run employment trends, there is also pronounced heterogeneity across occupations with respect to unconditional short-run employment dynamics, i.e., cyclical employ-

[2]Other studies consider two occupation categories distinguishing only between blue-collar occupations and a broader understanding of white-collar occupations which also include some pink-collar occupations (Lee 2005; Crinò 2010). Our results show that there are, however, important differences in employment dynamics between our pink-collar occupation category and our white-collar occupation category. Again other studies consider four occupation categories disentangling pink-collar occupations into service occupations on the one hand and sales and office occupations on the other hand (e.g., Jaimovich and Siu, 2012, and Foote and Ryan, 2014). As discussed above, we find that major subcategories of the pink-collar occupation group display similar employment dynamics.

[3]The term polarization is used because of the secular downward trend in the share of (medium pay) blue-collar employment relative to (low pay) service employment and (high pay) white-collar employment.

ment components which we measure by percentage deviations from log-linear trends. While employment of all three groups are highly correlated over the business cycle, they differ markedly in terms of volatility.[4] Blue-collar employment is the most volatile group. The standard deviation of cyclical blue-collar employment is 4.7% in our sample while white-collar and pink-collar employment fluctuate with standard deviations of 3.3% and 3.1%, respectively.

Besides employment, we also investigate further labor-market outcomes by occupation such as hours and wage rates as well as the allocation of occupations across industries.[5] For instance, we use information on relative wage dynamics to discriminate between alternative explanations of occupational employment dynamics. Descriptively, there are considerable differences in pay between occupation groups. On average over our sample, the hourly wage rate, measured in 2015 dollars, is about $23 for workers in white-collar occupations, $18 for workers in blue-collar occupations, and $15 for workers in pink-collar occupations. Average weekly hours per worker amount to roughly 38, 33, and 32.5 for white-collar, blue-collar, and pink-collar occupations, respectively, showing that differences in hours per worker between blue-collar and pink-collar occupations are rather small. As discussed before, there is a substantial gender segregation in particular between blue-collar and service, sales, and office occupations. Men constitute 84% of employed workers in blue-collar occupations but only 39% in service, sales, and office occupations.

Finally, blue-collar occupations and pink-collar occupations are not distributed evenly across industries. Blue-collar occupations are concentrated in natural-resource extraction, construction, manufacturing, and transportation industries where they represent more than 50% of total employment. By contrast, service, sales, and office occupations are over-represented especially in leisure and hospitality as well as in wholesale and retail sales industries. In the following, we document heterogeneous occupational employment dynamics conditional on fiscal-policy shocks and present empirical evidence that these heterogeneous dynamics are not simply reflections of industry dynamics or of the demographic characteristics of workers in different occupations.

[4] The correlations of the cyclical components of employment in white-collar, blue-collar, and pink-collar occupations with the cyclical component of aggregate employment are 0.95, 0.94, and 0.96, respectively.

[5] For this, we take into account that the official conversion factors used to construct consistent times series of employment by occupation do not necessarily yield consistent time series of other outcomes by occupation or of occupational employment within industries. We circumvent this issue by including dummies for reclassification dates when identifying cyclical and trend components, see Appendix A.1 for details.

2.2 Econometric method

As our baseline econometric strategy, we identify exogenous variations in government spending by estimating expectations-augmented vector-autoregressive models on quarterly U.S. data and using short-run identifying restrictions on the automatic response of government spending to economic activity. To take into account anticipation effects of government spending that are found to be important by Ramey (2011b), we include a fiscal news variable in our VAR.

The reduced-form VAR reads

$$Y_t = C + \sum_{i=1}^{q} B_0^{-1} B_i Y_{t-i} + B_0^{-1} \varepsilon_t \,, \tag{1}$$

where Y_t is a $k \times 1$ vector of k endogenous variables, C is a $k \times 1$ vector of constants, ε_t a $k \times 1$ vector of serially and mutually uncorrelated structural shocks, B_i is a $k \times k$ matrix (for every $i = 0, \ldots, q$), where B_0 comprises the parameters on the contemporaneous endogenous variables, and q is the maximal lag length. An equation-by-equation ordinary least squares regression of the reduced-form VAR (1) yields estimates of the coefficients $B^{-1}C_i$ (for every $i = 1, \ldots, q$) and the reduced form residuals $B^{-1}\varepsilon_t$, as well as the covariance matrix of the reduced-form residuals Σ.

Our baseline set of variables Y_t consists of government spending (real government consumption and gross investment per capita), output (real GDP per capita), the forecast for total government spending growth from the Survey of Professional Forecasters (the forecast made at time t for the growth rate of real government purchases for time $t + 1$), tax receipts (real value of government current tax receipts, deflated with the GDP deflator and expressed in per capita terms), the ratio of government debt to GDP, and the real interest rate (the annualized difference between the federal funds rate and the log-change in the GDP deflator). Our main interest lies in the analysis of the effects of government spending shocks on labor-market outcomes. We follow Burnside, Eichenbaum, and Fisher (2004)'s strategy of using a fixed set of macroeconomic aggregates (the variables mentioned above) and rotating in different labor-market variables of interest.

Our baseline sample period is 1983Q1-2015Q4, while we also consider a robustness check where we exclude the Great Recession and its aftermath. In our preferred specification, all variables are measured as deviations from linear trends, we include constants in the VAR and choose a lag length of three. In robustness checks, we consider alternative ways of handling trends in the data and find that our key results do not depend on the specific detrending method.

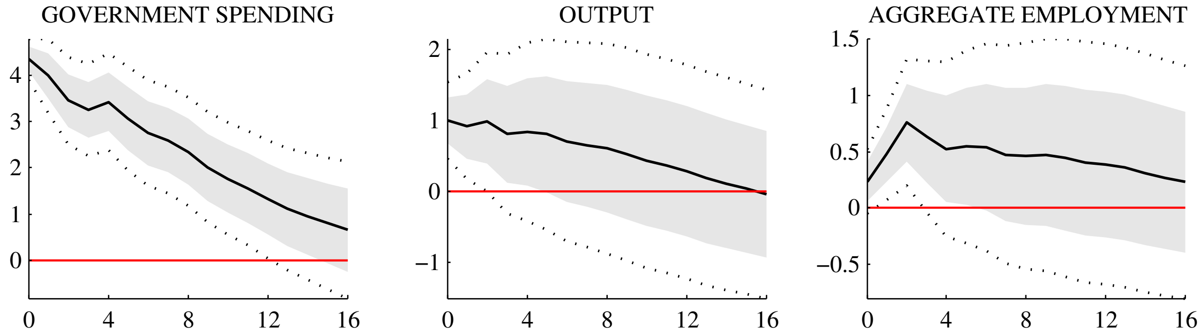
Identification of government spending shocks is achieved through a standard recursive identification scheme with government spending ordered first. Technically, we assume that B_0 is lower triangular. This implies that fiscal spending shocks are identified by assuming that government spending is exogenous within the quarter, for example due to institutional delays in the political and administrative process (Blanchard and Perotti, 2002). We address Ramey (2011b)'s anticipation critique by incorporating as a fiscal news variable the spending growth forecast following, e.g., Auerbach and Gorodnichenko (2012b). The innovation in government spending orthogonal to the forecast is an unanticipated shock to government spending in the sense that it was not foreseen by professional forecasters. Relying on professional forecasts to address anticipation follows Ramey (2011b)'s recommendation for a post-Korean war sample, for which Ramey (2011b, 2016) has shown that her military news variable has insufficient instrument relevance for identifying exogenous variation in government spending. The real interest rate, tax receipts, and public debt enter the VAR to control for the monetary policy stance and for the effects of the financing side of the government budget when identifying government spending shocks (Perotti, 1999, Rossi and Zubairy, 2011, Ramey, 2011b). In robustness checks, we consider alternative identifications schemes for government spending shocks.

3 Empirical results

Figure 1 displays the estimated responses of government spending, output, and aggregate employment to a government spending shock.[6] The horizontal axes show quarters after the shock and the responses are expressed in percentage terms. The shock is normalized such that output changes by 1% on impact. We observe a persistent rise in government spending and a significant increase in output. Government spending rises by 4.36 percent, which, together with an average sample share of government spending in GDP of 19.6 percent, translates into an impact output multiplier of 1.17. A government spending expansion also leads to a significant increase in aggregate employment. These results are well in line with the literature, see, e.g., Ramey (2011a, 2011b), Pappa

[6]The VAR further includes the real interest rate, tax receipts, the debt-to-gdp ratio, and the spending forecast as control variables. Figure A2 in Appendix C.1 shows the full set of impulse responses.

Figure 1: The effects of government spending shocks on macroeconomic aggregates.



Notes: Solid lines are impulse responses to a government spending shock. Grey shaded areas and dotted lines show 68 percent and 90 percent confidence bands. Responses are expressed in percentage terms. On the horizontal axes, the horizon is given in quarters. The impact response of output is normalized to one percent.

(2009), and Monacelli, Perotti, and Trigari (2010).[7]

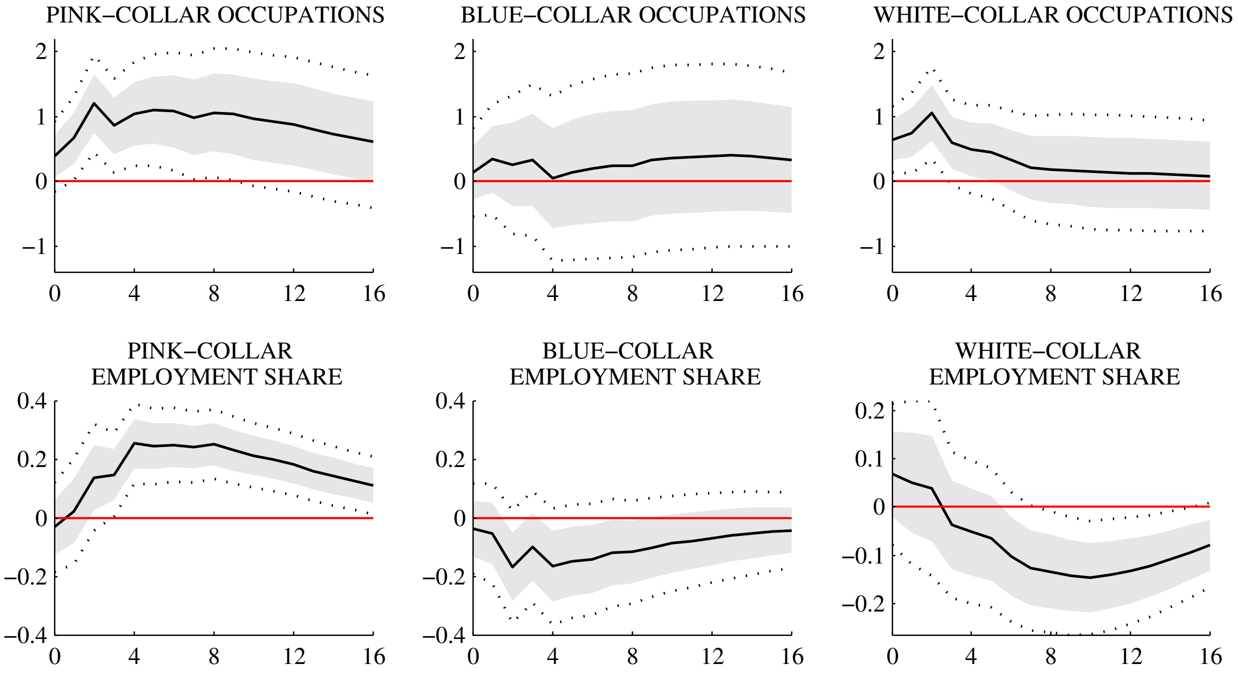
Our main interest is on the occupational employment dynamics after government spending shocks. Figure 2 reveals that employment reactions differ markedly across occupations. Employment in pink-collar occupations, i.e., service, sales, and office occupations, increases after a government spending expansion. A similar pattern is found for all three major subcategories of pink-collar occupations (see Figure A3 in Appendix C.2) although the responses differ somewhat in timing and shape. Importantly, employment in pink-collar occupations rises significantly more strongly than aggregate employment. As shown in the lower left panel of Figure 2, there is a significant, strong, and long-lasting increase in the share of pink-collar employment in total employment.

By contrast, for blue-collar employment, we do not observe a discernible change after a government spending expansion (see the upper-middle panel of Figure 2). Figure A4 in Appendix C.2 shows that there is also no significant employment increase in any of the four major occupation groups in the blue-collar category. Together with the rise in aggregate employment, this implies that the share of blue-collar employment in total employment declines considerably (see the lower-middle panel of Figure 2).

Employment in white-collar occupations expands after a government spending shock (see the upper-right panel in Figure 2) and, also here, responses are similar in the respective subcategories (see Figure A5 in Appendix C.2). However, the increase in white-collar employment is more or less proportionate relative to the rise in aggregate employment. The response of the share of

[7] Our estimate for the impact fiscal multiplier is within but closer to the upper bound of the interval by which Ramey (2011a, 2011b) summarizes the empirical literature.

Figure 2: Employment dynamics by occupation.

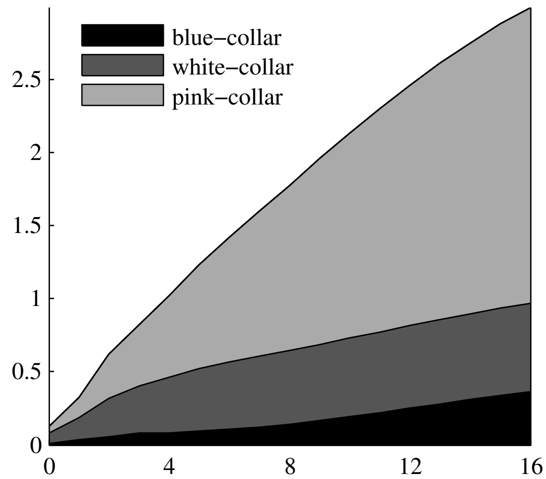


Notes: Solid lines are impulse responses to a government spending shock. Grey shaded areas and dotted lines show 68 percent and 90 percent confidence bands. Responses are expressed in percentage terms. On the horizontal axes, the horizon is given in quarters. The impact response of output (not shown) is normalized to one percent. Pink collar: service occupations; sales and related occupations; office and administrative support occupations. Blue collar: construction and extraction occupations; installation, maintenance, and repair occupations; production occupations; transportation and material moving occupations. White collar: management, business, and financial occupations; professional and related occupations.

white-collar employment in total employment is small and indistinguishable from zero for the first 6 quarters; only in the medium run, there is a significant decline in the white-collar employment share, which reflects the more short-lived increase in white-collar employment relative to aggregate employment. However, the estimated response of relative white-collar employment should be considered with caution, as, other than the responses of pink-collar and blue-collar employment, the response of white-collar employment will be shown to be quite sensitive to specification and identification.

Figure 3 documents that the estimated differences across pink-collar, blue-collar, and white-collar occupations are quantitatively important. The figure shows cumulative job changes by occupation group (job years, in millions) for a 16-quarter horizon. After the first year, cumulated employment gains are about 600,000 job years in pink-collar occupations, about 400,000 job years in white-collar occupations, and about 80,000 job years in blue-collar occupations. Hence, employment gains accrue disproportionately in pink-collar occupations (55% of the additional jobs

Figure 3: Cumulated employment changes by occupation group (in millions of job years).



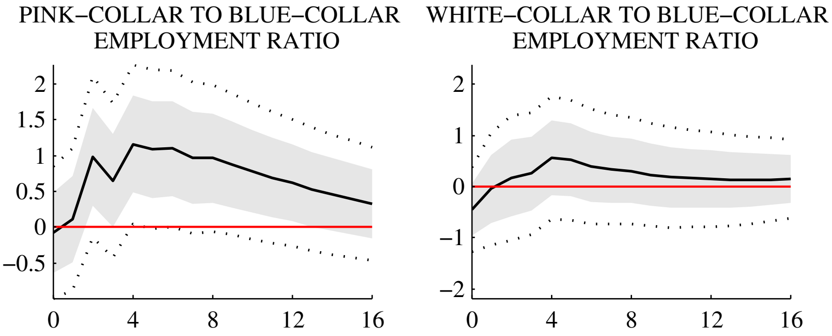
Notes: Cumulated employment effects calculated as cumulated percentage response by occupation group (see Figure 2) multiplied by average employment by occupation group (about 54.3 million for pink-collar occupations, 43.2 million for white-collar occupations, 30.1 million for blue-collar occupations).

compared to an average sample share of 42%) and less than proportionately in blue-collar occupations (8% compared to 23%). White-collar employment is affected more or less proportionately (37% compared to 34%). After four years, the cumulative employment effect in pink-collar occupations is almost seven times as large as in blue-collar occupations while the sample average of pink-collar employment is less than twice as large as that of blue-collar employment. The cumulated employment effect in white-collar occupations is almost three times as large as the one in blue-collar occupations while the sample average of white-collar employment is about one and half times as large as that of blue-collar employment.

We now investigate the employment gains in pink-collar and white-collar occupations relative to blue-collar occupations. The left panel of Figure 4 shows that, relative to blue-collar employment, pink-collar employment rises by about one percentage point. This increase is substantial and the difference in employment dynamics between the two occupation groups is statistically significant. By contrast, the increase in relative white-collar employment is less strong, less significant, and peaks at only about half a percent (see the right panel of Figure 4).

We have corroborated both results in a series of robustness checks which we discuss in more detail in Appendix C.3. The finding that expansionary fiscal policy leads to a shift in the composition of employment away from blue-collar employment toward pink-collar employment is not specific to the baseline specification of our VAR but is obtained for a wide range of re-specifications

Figure 4: Occupational employment ratios.



Notes: Solid lines are impulse responses to a government spending shock. Grey shaded areas and dotted lines show 68 percent and 90 percent confidence bands. Responses are expressed in percentage terms. On the horizontal axes, the horizon is given in quarters. The impact response of output (not shown) is normalized to one percent.

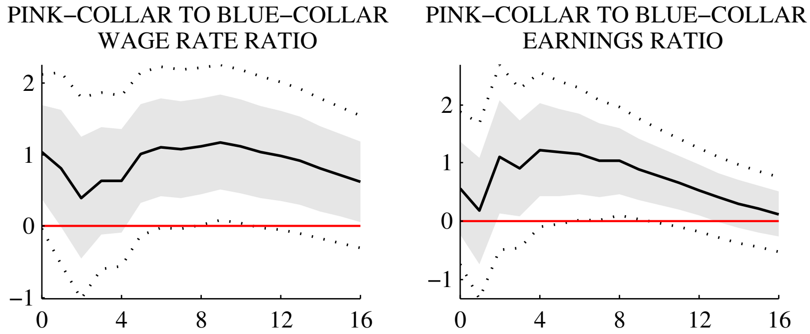
of the empirical model. In particular, we obtain this result for alternative ways of handling trends in the data, for alternative identifications of fiscal policy shocks, when we exclude the time of the Great Recession from the data sample, and independent of whether we consider total government spending or components of government expenditures. We also find an increase in pink-collar hours per worker relative to blue-collar hours per worker (and the same pattern also for total hours worked) implying that developments at both the intensive and the extensive margin work in the same direction. By contrast, we find mixed results for the estimated response of white-collar employment relative to blue-collar employment, as some specifications suggest a significant increase and others do not.

In summary, our analysis has uncovered one main result that is a significant, robust, and quantitatively important feature of the data: a fiscal stimulus increases pink-collar employment relative to blue-collar employment. The remainder of this paper is about understanding this consequence of fiscal policy. We will discuss later how the less clear-cut evidence on relative white-collar employment relates to our main finding and to our theoretical model in particular.

4 Understanding heterogeneous occupational employment dynamics

We now perform a number of empirical evaluations in order to investigate why pink-collar employment rises relative to blue-collar employment in response to fiscal expansions. We first consider the response of relative occupational wage rates. The left panel of Figure 5 shows that wage rates of pink-collar workers rise relative to those of blue-collar workers. Thus, our evidence shows a

Figure 5: Pink-collar to blue-collar wage rate ratio and earnings ratio.



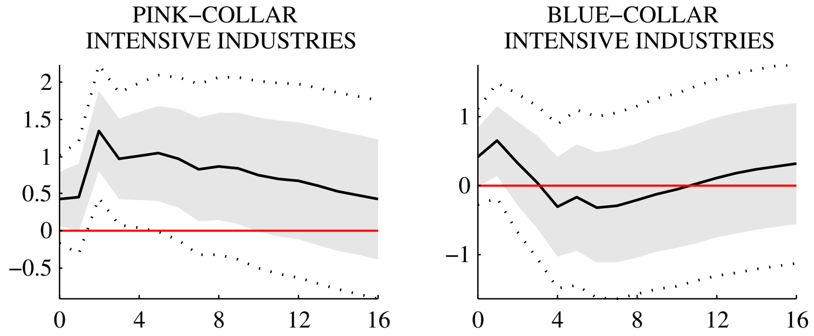
Notes: Solid lines are impulse responses to a government spending shock. Grey shaded areas and dotted lines show 68 percent and 90 percent confidence bands. Responses are expressed in percentage terms. On the horizontal axes, the horizon is given in quarters. The impact response of output (not shown) is normalized to one percent. Average hourly wage rate is total earnings divided by total hours worked.

positive co-movement of relative occupational employment and relative occupational wage rates. This finding is important because it indicates that occupation-specific changes in labor demand rather than in labor supply are key for understanding the heterogeneous occupational employment effects of fiscal expansions. Put differently, firms increase their demand for service, sales, and office workers by more than their demand for blue-collar workers. For completeness, the right panel of Figure 5 displays the response of relative occupational labor earnings. As employment, hours, and wage rates shift in favor of pink-collar workers, also their earnings increase relative to blue-collar workers. Put differently, in response to an increase in government spending, the distribution of labor earnings shifts toward workers in pink-collar occupations.

The next step is to address why labor demand shifts away from blue-collar labor and toward pink-collar labor in response to fiscal expansions. We document that this is due to two effects. First, there is a between-industry effect, i.e., disproportionate employment growth in industries employing pink-collar occupations disproportionately which leads to a shift in aggregate labor demand toward pink-collar labor and raises the aggregate pink-collar to blue-collar employment ratio through a composition effect. Second, there is a within-industry effect, i.e., the share of pink-collar work increases within industries. Thus, both the between-industry and the within-industry effect operate in the same direction so that the employment ratio increases in the aggregate.

Figures 6 and 7 show that both effects contribute to the overall rise in the pink-collar to blue-collar employment ratio. Figure 6 illustrates the between-industry effect. It shows the responses of employment in pink-collar intensive industries such as wholesale and retail trade as well as

Figure 6: Industry-specific employment.



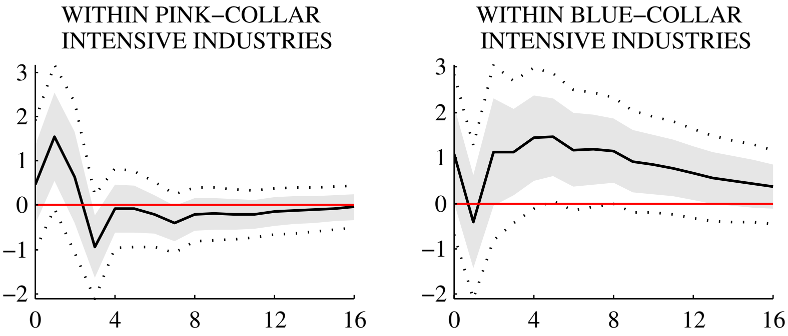
Notes: Solid lines are impulse responses to a government spending shock. Grey shaded areas and dotted lines show 68 percent and 90 percent confidence bands. Responses are expressed in percentage terms. On the horizontal axes, the horizon is given in quarters. The impact response of output (not shown) is normalized to one percent. Left (right) panel: employment in private-sector major industries in which the average sample share of pink-collar (blue-collar) workers is larger than in aggregate employment.

leisure and hospitality (left panel) and in blue-collar intensive industries such as construction, manufacturing, and transportation (right panel) to fiscal expansions.[8] We observe that employment in pink-collar intensive industries responds more strongly and more persistently than employment in blue-collar intensive industries. Thus, the disproportionate employment growth in service, sales and office occupations observed in the data is in part a result of disproportionate employment growth in industries employing workers in these occupations disproportionately. Put differently, blue-collar workers may not benefit much from fiscal expansions because fiscal expansions do not trigger significant employment growth in blue-collar intensive industries such as production and manufacturing.

Figure 7 illustrates the within-industry effect. It shows responses of the pink-collar to blue-collar employment ratios *within* the two industry groups (pink-collar intensive and blue-collar intensive industries). We find that there are substantial changes in the composition of occupational employment within industry groups. In particular, we observe a substantial rise in the employment ratio of pink-collar to blue-collar occupations within pink-collar intensive industries (left panel) as well as within blue-collar intensive industries (right panel), as we do in the aggregate. The shapes of the responses show that the dynamics of relative pink-collar employment

[8]We define an industry to be pink-collar intensive if the share of pink-collar workers in this industry is higher than the pink-collar share in aggregate employment. Blue-collar intensive industries are defined analogously. Major industries defined as pink-collar intensive are Wholesale and retail trade, Financial activities, Leisure and hospitality, Other services, and Public administration. In Figures 6 and 7, we focus on private sector employment. The role of employment in public administration will be addressed later. Major industries defined as blue-collar intensive are Mining, quarrying, and oil and gas extraction, Construction, Manufacturing, Transportation and utilities, and Information.

Figure 7: Pink-collar to blue-collar employment ratio within industries.



Notes: Solid lines are impulse responses to a government spending shock. Grey shaded areas and dotted lines show 68 percent and 90 percent confidence bands. Responses are expressed in percentage terms. On the horizontal axes, the horizon is given in quarters. The impact response of output (not shown) is normalized to one percent. Left (right) panel: pink-collar to blue-collar employment ratio within private-sector major industries in which the average sample share of pink-collar (blue-collar) workers is larger than in aggregate employment.

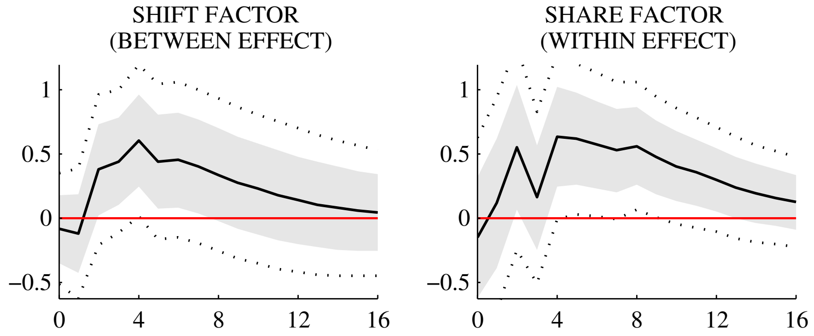
within blue-collar intensive industries resemble the one observed in the total economy, while the differential occupational employment dynamics are more short-lived within pink-collar intensive industries. Importantly, the increase in relative pink-collar employment within industries shows that the documented heterogeneous occupational employment dynamics are not only a relabeling of heterogeneous employment dynamics across industries but are also driven by within-industry changes favoring pink-collar employment.

Shift-share decomposition. While the previous analysis has illustrated the between-effect and the within-effect for two industry groups, we now provide evidence exploiting information from all 130 major industry-occupation cells. We do so by applying a standard shift-share decomposition following Bárány and Siegel (2018). Specifically, we decompose the change in employment in an occupation group o into a shift component and a share component. The change in employment in occupation o at time t, $\Delta emp_{o,t}$, is given by

$$\Delta emp_{o,t} = \underbrace{\sum_i s_{o,i,t} \cdot \Delta emp_{i,t}}_{\Delta emp_{o,t}^{between}} + \underbrace{\sum_i \Delta s_{o,i,t} \cdot emp_{i,t}}_{\Delta emp_{o,t}^{within}},$$

where $s_{o,i,t}$ is the employment share of occupation o in industry i at time t (the share of industry-i workers who have occupation o) and $emp_{i,t}$ is employment in industry i at time t. From this, we calculate the time series of the pink-collar to blue-collar employment ratio implied by the shift factor and implied by the share factor, see Appendix C.4 for details. The shift factor captures

Figure 8: Shift-share decomposition.



Notes: Solid lines are impulse responses to a government spending shock. Grey shaded areas and dotted lines show 68 percent and 90 percent confidence bands. Responses are expressed in percentage terms. On the horizontal axes, the horizon is given in quarters. The impact response of output (not shown) is normalized to one percent.

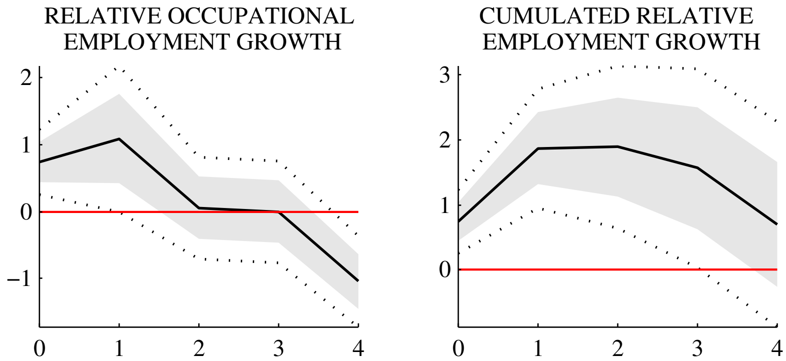
between-industry dynamics and the share factor captures within-industry occupation dynamics. We then include these factors separately in our VARs to study how the two components of relative occupational employment respond to fiscal expansions.

Figure 8 shows the results. We find that, both, the shift factor that captures between-industry dynamics and the share factor that captures within-industry occupation dynamics contribute significantly to the rise in relative pink-collar employment in response to a government spending shock. Quantitatively, both factors explain a rise in pink-collar employment relative to blue-collar employment by about 0.5% percentage points, hence about half of the total increase in relative pink-collar employment.

Exploiting across-industry variation of government spending. To provide additional evidence for occupation-specific employment dynamics within industries, we now apply an identification strategy similar to the one developed by Nekarda and Ramey (2011). As discussed by Ramey and Shapiro (1998) and Nekarda and Ramey (2011), there is substantial heterogeneity in the degree to which different industries are exposed to specific government spending hikes. Nekarda and Ramey (2011) exploit this heterogeneity at the industry level to estimate the effects of government purchases. We follow Nekarda and Ramey (2011) and construct industry-specific government demand variables by using information from input-output (IO) tables and merge these variables with the NBER Manufacturing Industry Database (MID) which gives yearly data for a panel of 274 manufacturing industries.[9] We then estimate impulse responses using local projections on the

[9]The government demand instrument is constructed as $\Delta \ln g_{it} = \theta_i \cdot \Delta \ln G_t$, where $\Delta \ln G_t$ is the aggregate change in real federal government spending (from NIPA data) and θ_i is a time-invariant industry-specific weight measured

Figure 9: Panel-data evidence on the within-industry effect.



Notes: The figure shows outcomes for non-production occupations (supervisors above the line-supervisor level, clerical, sales, office, professional, and technical workers) relative to production occupations (other occupations). Solid lines are impulse responses to a government spending shock. Grey shaded areas and dotted lines show 68 percent and 90 percent confidence bands. Responses are expressed in percent. On the horizontal axes, the horizon is given in years.

instruments of industry-specific growth rates of government spending in a panel of industries.

As dependent variable we consider relative occupational employment growth within an industry. Hence, we estimate how government spending in an industry affects relative occupational employment in that same industry. Thereby, we isolate the within-industry effect discussed above as the analysis abstracts from between-industry effects. When using the MID, we have to consider broader occupation groups because this dataset has separate information on employment of production and on employment of non-production workers only. Production workers in the MID "exclude supervisors above the line-supervisor level, clerical, sales, office, professional, and technical workers" (see MID manual) and hence are essentially blue-collar workers.

Figure 9 shows impulse responses over a 4-year horizon from our baseline specification. A detailed description of our analysis and further results can be found in Appendix C.5. The left panel of Figure 9 shows that employment growth in non-production occupations is significantly stronger than in production occupations. The right panel shows the cumulated effect on relative occupational employment growth which is very closely related to the response of the relative occupational employment levels considered in our baseline VAR analysis. The figure shows that employment in non-production occupations increases significantly relative to employment in production occupations and the effect also shows the hump-shaped form known from our VAR results.

The results of this exercise corroborate that there are significant within-industry occupational

as the long-run average share of shipments to the government in industry i (from the IO tables).

employment dynamics in response to fiscal policy shocks. The results are, however, not directly comparable to our baseline VAR results since the panel-data analysis neglects general-equilibrium effects and can only be performed for a subset of industries, a broad classification of occupations, and federal spending, see Appendix C.5 for a more detailed discussion.

Alternative explanations. We have performed a number of empirical evaluations to rule out that other explanations play a major role for the documented aggregate rise in relative pink-collar employment. We summarize these evaluations here and discuss them in more detail in Appendix C.6.

First, an expansion in government employment – where the share of pink-collar workes is disproportionately large – could explain a rise in relative pink-collar employment in the aggregate. However, we observe a shift from blue-collar to pink-collar employment also when excluding employees working in the public sector (see Figure A10 in Appendix C.6). We can also rule out that the empirical findings are primarily driven by spill-overs from expansions of the government wage bill (Ardagna 2007; Bermperoglou, Pappa, and Vella 2017) because we also observe a rise in relative pink-collar employment when we consider a shock to government non-wage spending (see Figure A8 in Appendix C.6).

Second, there may be different labor-supply reactions across occupations groups due to different characteristics of workers. Since occupations are not evenly distributed across population groups, this would also impact on relative occupational employment in the aggregate. However, we observe a shift from blue-collar to pink-collar employment also *within* groups of workers with similar characteristics such as gender and age (see Figure A11 in Appendix C.6).

Summary. Our empirical evidence has shown that occupation-specific within-industry shifts in labor demand in favor of pink-collar workers are key for understanding the documented heterogeneous employment dynamics in response to government spending expansions. This is reinforced by a between-industry effect, i.e., disproportionate employment growth in industries that employ large shares of pink-collar workers. Taken together, the evidence has shown that there are labor-demand forces that pull individuals into pink-collar employment, as is also strongly indicated by the evidence on relative occupational wages. In the next section, we build a model explaining these occupation-specific labor-demand forces.

5 The model

In this section, we provide a theoretical explanation for why aggregate labor demand shifts toward pink-collar work after fiscal expansions. In line with our empirical findings, our model explanation builds on two factors that are found to be of about equal importance in our empirical investigation. The first factor is the composition effect due to heterogeneous employment changes across industries. The second factor is the within-industry employment shift in favor of pink-collar occupations. In order to understand the second factor, i.e., why firms in a given industry adjust their demand for labor in different occupations differently, it is important to understand what distinguishes pink-collar occupations from blue-collar occupations in the production process. Autor and Dorn (2013) have established that the degree of substitutability between capital and labor differs across occupations. While their analysis relates to the long-run, we highlight the role of differences in the degree of substitutability for short-run dynamics. Specifically, our explanation builds on the notion that labor provided by blue-collar occupations is on average more easily substitutable with capital than labor provided by pink-collar occupations. In a short-run business-cycle context, this amounts to the assumption that there are differences in the substitutability of occupational labor with capital *services*, i.e., the stock of physical capital times the intensity with which it is used.[10] Pink-collar employees, the majority of whom are workers in service occupations, perform tasks that include a substantial share of human interaction that is difficult to provide through machines. Accordingly, pink-collar labor and capital services are, on average, relatively poor substitutes. Blue-collar workers, by contrast, perform routine-manual labor including a substantial share of interaction with capital/machines (Jaimovich and Siu 2012; Foote and Ryan 2014) that can be used in different intensities, making blue-collar labor and capital services relatively close substitutes.

In the following, we embed differences in the short-run substitutability of capital services with blue-collar and pink-collar labor into a two-industry New Keynesian business-cycle model. The model is able to replicate the empirical evidence on the effects of fiscal shocks on output, aggregate

[10] This distinguishes our approach from Autor and Dorn (2013) who explain differences in long-run occupational employment trends as a consequence of some types of occupational labor being substitutes, while others are complements, to quality-improved, new generations of capital. In our short-run perspective, what matters are differences in the degree of substitutability of occupational labor with the quantity of existing capital types and the intensity with which existing capital is used.

employment, and relative occupational labor-market outcomes.

After a fiscal expansion, firms within both industries demand more factor inputs to meet increased product demand. Since the short-run supply of capital services is relatively more elastic compared to the supply of labor[11], factor costs change in favor of capital use compared to labor. Therefore, firms raise their demand for capital services more than their demand for labor, in line with empirical evidence showing a significant increase in the utilization to labor ratio after fiscal expansions (see Figure A12 in Appendix C.7). The disproportionate surge in capital usage lowers the marginal productivity of its closer substitute, blue-collar labor, relative to pink-collar labor. As a consequence, firms in each industry increase their demand for pink-collar labor by more than their demand for blue-collar labor, thereby generating a relative pink-collar employment boom within industries that is associated with a rise in relative pink-collar wages.

At the same time, we allow for heterogeneity in factor intensities across industries and consider one representative pink-collar intensive industry and one representative blue-collar intensive industry. Together with the fact that, on average, the government buys a disproportionate share of goods and services produced in the pink-collar intensive industry, the model generates disproportionate employment growth in the pink-collar intensive industry, as observed in the data. This, in turn, causes an increase in the aggregate pink-collar to blue-collar employment ratio through a composition effect and puts upward pressure on relative pink-collar wages. The two effects together cause a strong rise in aggregate pink-collar employment relative to blue-collar employment.

5.1 Model set-up

We consider a two-industry economy consisting of firms, households, and the government. Firms in each industry produce differentiated goods under monopolistic competition and face costs of price adjustment. Production inputs are capital services and two types of occupational labor, pink-collar and blue-collar labor. The output of each industry is used for investment, consumption, and government spending. Households are families whose members differ by occupation and can work in either industry. The government consists of a monetary and fiscal authority. The monetary authority sets the short-term nominal interest rate while the fiscal authority collects income taxes,

[11]There is strong empirical support for this assumption. The elasticity of capital utilization is usually estimated to be considerably larger than Frisch labor supply elasticities. See, for example, Schmitt-Grohé and Uribe (2012), Smets and Wouters (2007), or Christiano, Eichenbaum, and Evans (2005).

issues short-term government bonds, pays transfers, and purchases goods from both industries for government consumption. A variable without a time subscript denotes its steady-state level.

Firms. Each industry (or sector) $s = 1, 2$ produces a final good and a continuum of intermediate goods indexed by j, where j is distributed over the unit interval. Each intermediate good is produced by a single firm. There is monopolistic competition in the markets for intermediate goods. Final goods firms in each industry use intermediate goods $y_{j,s,t}$, taking as given their price $p_{j,s,t}$, and sell the output $y_{s,t}$, at the competitive price $p_{s,t}$. The production function of the industry-s final good is $y_{s,t} = \left(\int_0^1 y_{j,s,t}^{(\epsilon-1)/\epsilon} di\right)^{\epsilon/(\epsilon-1)}$, where $\epsilon > 1$ is the elasticity of substitution between different varieties.

Firm j in industry s produces its output $y_{j,s,t}$ using capital services $\tilde{k}_{j,s,t}$, two types of labor, blue-collar labor $n^b_{j,s,t}$ and pink-collar labor $n^p_{j,s,t}$, and the following nested normalized CES production technology:

$$y_{j,s,t} = y_{j,s} \cdot \left(\alpha_s \cdot \left(\frac{v_{j,s,t}}{v_{j,s}} \right)^{\frac{\theta-1}{\theta}} + (1-\alpha_s) \cdot \left(a_t \cdot \frac{n^p_{j,s,t}}{n^p_{j,s}} \right)^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}}, \tag{2}$$

where $v_{j,s,t}$ is a normalized CES bundle of capital services and blue-collar labor:

$$v_{j,s,t} = v_{j,s} \cdot \left(\gamma_s \cdot \left(\frac{\tilde{k}_{j,s,t}}{\tilde{k}_{j,s}} \right)^{\frac{\phi-1}{\phi}} + (1-\gamma_s) \cdot \left(a_t \cdot \frac{n^b_{j,s,t}}{n^b_{j,s}} \right)^{\frac{\phi-1}{\phi}} \right)^{\frac{\phi}{\phi-1}}.$$

The parameter $\phi > 0$ measures the elasticity of substitution between capital services and labor in the representative blue-collar occupation, the parameter $\theta > 0$ measures the elasticity of substitution between the input bundle $v_{j,s,t}$ and labor in the representative pink-collar occupation. The parameters $\alpha_s \in (0, 1)$ and $\gamma_s \in (0, 1)$ reflect factor intensities in production. The normalization of the CES production technology allows to disentangle the factor intensitities α_s and γ_s from the elasticities of substitution ϕ and θ (see, e.g., León-Ledesma, McAdam, and Willman, 2010). The term a_t is a labor productivity shifter which follows the exogenous AR(1) process $\log a_t = (1-\rho_a)\log a + \rho_a \log a_{t-1} + \varepsilon^a_t$, where ε^a_t is *i.i.d.* and follows a Gaussian distribution $N(0, \sigma^2_{\varepsilon^a})$. This production technology resembles the one used by Autor and Dorn (2013).[12] It

[12] In their model, there is a CES aggregate of "routine" (blue-collar) labor and capital which is then aggregated with non-routine "manual services" (pink-collar) labor in a second CES function. In contrast to Autor and Dorn (2013), we abstract from "abstract" (white-collar) labor which Autor and Dorn (2013) incorporate in an intermediate step.

allows for industry-specific factor intensities α_s and γ_s and different degrees of substitutability between capital services on the one hand and pink-collar or blue-collar labor, respectively, on the other hand. For $\phi > \theta$, blue-collar labor is the closer substitute to capital services compared to pink-collar labor and vice versa for $\phi < \theta$. For $\phi \to 1$ and simultaneously $\theta \to 1$, the production function collapses to Cobb-Douglas where the elasticity of substitution between any two factors is one.

The firm chooses $\tilde{k}_{j,s,t}$, $n^b_{j,s,t}$, and $n^p_{j,s,t}$ to minimize its costs (deflated by the consumer price index p_t)

$$\mathrm{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{\lambda_t}{\lambda_0} \left\{ w^b_{s,t} n^b_{j,s,t} + w^p_{s,t} n^p_{j,s,t} + r^k_{s,t} \tilde{k}_{j,s,t} + \frac{\kappa_{n,s}}{2} \left[\left(\frac{n^b_{j,s,t}}{n^b_{j,s,t-1}} - 1 \right)^2 + \left(\frac{n^p_{j,s,t}}{n^p_{j,s,t-1}} - 1 \right)^2 \right] \frac{p_{s,t}}{p_t} y_{s,t} \right\},$$

subject to (2), where $w^b_{s,t}$ and $w^p_{s,t}$ are industry-specific real wages for blue-collar and pink-collar labor, respectively, $r^k_{s,t}$ is the industry-specific rental rate of capital services, and $\frac{\kappa_{n,s}}{2} \left(n^o_{j,s,t}/n^o_{j,s,t-1} - 1 \right)^2$ are quadratic labor adjustment costs for occupation $o = p, b$, expressed in units of the final consumption good, where the industry-specific parameter $\kappa_{n,s} \geq 0$ measures the extent of labor adjustment costs in the respective industry. The firm takes factor prices as given. The term $\beta^t \lambda_t / \lambda_0$ denotes the stochastic discount factor for real payoffs, where λ_t is the marginal utility of real income of the representative household that owns the firm, and $\beta \in (0, 1)$ is the households' discount factor.

The firm faces a quadratic cost of price adjustment. It chooses its price $p_{j,s,t}$ to maximize the discounted stream of profits, expressed in units of the final consumption good,

$$\mathrm{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{\lambda_t}{\lambda_0} \left(\frac{p_{j,s,t}}{p_{s,t}} \cdot \frac{p_{s,t}}{p_t} \cdot y_{j,s,t} - mc_{j,s,t} \cdot y_{j,s,t} - \frac{\psi}{2} \left(\frac{p_{j,s,t}}{p_{j,s,t-1}} - 1 \right)^2 \frac{p_{s,t}}{p_t} y_{s,t} \right), \tag{3}$$

subject to the demand function for variety j, $y_{j,s,t} = \left(p_{j,s,t}/p_{s,t} \right)^{-\epsilon} y_{s,t}$, where $y_{s,t}$ is aggregate demand for the good of industry s, $p_{j,s,t}/p_{s,t}$ is the relative price of variety j within the industry, and $p_{s,t} = \left(\int_0^1 p^{1-\epsilon}_{j,s,t} di \right)^{1/(1-\epsilon)}$ is the price index of industry s. $mc_{j,s,t}$ denotes real marginal costs. The final term in (3) represents the costs of price adjustment, where $\psi \geq 0$ measures the degree of nominal price rigidity. Firms' first-order conditions can be found in Appendix D.1.

Households. There is a continuum of infinitely-lived households, with mass normalized to one. Each household supplies pink-collar and blue-collar labor to both industries. We keep the labor-supply side of our model simple and do not model flows between occupations in order to focus on the occupation-specific demand forces which, according to our evidence, are key to understand the occupational employment dynamics in response to fiscal stimulus.[13] We assume a unitary household that cares about its total consumption level c_t of a composite good (consisting of goods of both industries) and receives disutility from both types of labor, n_t^p and n_t^b. With this modelling assumption, our theoretical analysis should be understood as a positive analysis, while our model is not supposed to allow a normative analysis of the distributional effects of fiscal policy. We do not distinguish between the extensive margin and the intensive margin of employment which is supported by the empirical evidence showing that similar developments occur at both margins (see Figure A6 in Appendix C.3).

Each household maximizes its lifetime utility function

$$\mathrm{E}_0 \sum_{t=0}^{\infty} \beta^t u(c_t, n_t^p, n_t^b), \tag{4}$$

where c_t is consumption of a composite good, defined as an aggregate of consumption of the industry-1 good, $c_{1,t}$, and consumption of the industry-2 good, $c_{2,t}$, with substitution elasticity $\mu > 0$,

$$c_t = \left(\zeta^{\frac{1}{\mu}} \cdot (c_{1,t})^{\frac{\mu-1}{\mu}} + (1-\zeta)^{\frac{1}{\mu}} \cdot (c_{2,t})^{\frac{\mu-1}{\mu}} \right)^{\frac{\mu}{\mu-1}} . \tag{5}$$

Given a decision on the composite consumption good c_t, the household allocates optimally the expenditure on consumption of good 1 and good 2 by minimizing total expenditures $p_{1,t}c_{1,t}+p_{2,t}c_{2,t}$, subject to (5). Following Horvath (2000), we assume that members of each household supply labor to firms in both industries according to

$$n_t^o = \left((\aleph^o)^{-\frac{1}{\omega}} \cdot \left(n_{1,t}^o\right)^{\frac{1+\omega}{\omega}} + (1-\aleph^o)^{-\frac{1}{\omega}} \cdot \left(n_{2,t}^o\right)^{\frac{1+\omega}{\omega}} \right)^{\frac{\omega}{1+\omega}} , \quad \text{for} \quad o = p, b. \tag{6}$$

The parameter $\omega > 0$ controls the degree of labor mobility across sectors. For $\omega \to \infty$, labor can be freely reallocated and all sectors pay the same hourly wage at the margin. For $\omega < \infty$ there is a

[13] Further, empirical evidence shows that occupation switches are associated with substantial costs (e.g., Kambourov and Manovskii, 2009, Artuç and McLaren, 2015, Cortes and Gallipoli, 2017) and occur rarely (e.g., Moscarini and Thomsson, 2007, Fujita and Moscarini, 2013, Foote and Ryan, 2014).

limited degree of sectoral labor mobility and sectoral wages are not equalized. Given a decision on n_t^p and n_t^b, the household allocates optimally the supply of labor to sectors 1 and 2 by maximizing, for $o = p, b$, real wage income $w_{1,t}^o n_{1,t}^o + w_{2,t}^o n_{2,t}^o$, subject to (6).

Following Jaimovich and Rebelo (2009), the period utility function $u(c_t, n_t^p, n_t^b)$ takes a form that allows to parameterize the wealth effect on labor supply:

$$u(c_t, n_t^p, n_t^b) = \frac{\left(c_t - \left(\frac{\Omega^p}{1+1/\eta}(n_t^p)^{1+1/\eta} + \frac{\Omega^b}{1+1/\eta}(n_t^b)^{1+1/\eta}\right) x_t\right)^{1-1/\sigma} - 1}{1 - 1/\sigma},$$

where $\sigma > 0$ is the intertemporal elasticity of substitution in consumption, $\Omega^p > 0$ and $\Omega^b > 0$ are scale parameters, x_t is a weighted average of current and past consumption evolving over time according to

$$x_t = c_t^{\chi} x_{t-1}^{1-\chi}, \tag{7}$$

$\chi \in (0, 1]$ governs the wealth elasticity of labor supply, and $\eta > 0$ is the Frisch elasticity of labor supply in the limiting case $\chi \to 0$. In this case, there is no wealth effect on labor supply and preferences are of the type considered by Greenwood, Hercowitz, and Huffman (1988).

The household's period-by-period budget constraint (in real terms) is given by

$$\begin{aligned} c_t + \frac{p_{1,t}}{p_t} i_{1,t} + \frac{p_{2,t}}{p_t} i_{2,t} + b_t = {} & (1 - \tau_t)\left(w_t^p n_t^p + w_t^b n_t^b + r_{1,t}^k \tilde{k}_{1,t} + r_{2,t}^k \tilde{k}_{2,t}\right) + T_t + d_t \\ & - \frac{p_{1,t}}{p_t} e(u_{1,t}) k_{1,t-1} - \frac{p_{2,t}}{p_t} e(u_{2,t}) k_{2,t-1} + (1 + r_{t-1}) \frac{b_{t-1}}{\pi_t}, \end{aligned} \tag{8}$$

where $p_t = \left(\zeta \cdot p_{1,t}^{1-\mu} + (1 - \zeta) \cdot p_{2,t}^{1-\mu}\right)^{1/(1-\mu)}$ is the price of the composite good c_t, $i_{s,t}$ is investment into physical capital in industry s, b_{t-1} is the beginning-of-period stock of real government bonds, τ_t is the income tax rate, $k_{s,t-1}$ denotes the beginning-of-period capital stock in industry s, $u_{s,t}$ is capital utilization in industry s, $e(u_{s,t})$ are the costs of capital utilization in industry s, T_t are government transfers, $d_t = d_{1,t} + d_{2,t}$ are dividends from the ownership of firms in both industries, r_t is the nominal interest rate, $\pi_t = p_t/p_{t-1}$ is consumer price inflation, and $w_t^o = \left(\aleph^o \cdot (w_{1,t}^o)^{1+\omega} + (1 - \aleph^o) \cdot (w_{2,t}^o)^{1+\omega}\right)^{1/(1+\omega)}$ is the aggregate real wage for occupation $o = p, b$.

Following Ramey and Shapiro (1998), we assume that capital goods for a particular industry must be produced within that industry. Thus, the capital stock in each industry evolves according to the following law of motion

$$k_{s,t} = (1-\delta)k_{s,t-1} + \left(1 - \frac{\kappa_i}{2}\left(\frac{i_{s,t}}{i_{s,t-1}} - 1\right)^2\right) i_{s,t}\,, \quad s = 1, 2\,, \tag{9}$$

where $\delta \in (0,1)$ is the capital depreciation rate and $\frac{\kappa_i}{2}\left(i_{s,t}/i_{s,t-1} - 1\right)^2$ represents investment adjustment costs with $\kappa_i \geq 0$.

Households choose capital utilization rates $u_{s,t}$, which transform physical capital in industry s into capital services $\tilde{k}_{s,t}$ according to $\tilde{k}_{s,t} = u_{s,t}k_{s,t-1}$. Costs of capital utilization are given by

$$e(u_{s,t}) = \delta_1(u_{s,t} - 1) + \frac{\delta_2}{2}(u_{s,t} - 1)^2\,, \quad s = 1, 2\,,$$

which implies the absence of capital utilization costs at the deterministic steady state in which capital utilization is normalized to $u_s = 1$. The elasticity of capital utilization with respect to the rental rate of capital, evaluated at the steady state, is given by $\Delta = \delta_1/\delta_2 > 0$. As capital is predetermined, Δ corresponds to the short-run elasticity of the supply of capital services. The relative size between this elasticity and the elasticity of labor supply, η, will be important for replicating the empirical evidence on within-industry effects, as illustrated below.

Households choose quantities (c_t, x_t, b_t, $k_{s,t}$, $i_{s,t}$, $u_{s,t}$, n_t^b, and n_t^p), taking as given the set of prices (w_t^p, w_t^b, p_t, $p_{s,t}$, $r_{s,t}^k$, and r_t), dividends (d_t), transfers (T_t), and taxes (τ_t), to maximize (4) subject to (7), (8) and (9). First-order conditions can be found in Appendix D.1.

Market clearing, monetary and fiscal policy. The fiscal authority finances transfers and an exogenous stream of government spending g_t by income taxes. The government consumption bundle comprises goods 1 and 2 in a similar way than that of households,

$$g_t = \left(\zeta_g^{\frac{1}{\mu}} \cdot (g_{1,t})^{\frac{\mu-1}{\mu}} + (1-\zeta_g)^{\frac{1}{\mu}} \cdot (g_{2,t})^{\frac{\mu-1}{\mu}}\right)^{\frac{\mu}{\mu-1}}\,, \tag{10}$$

where ζ_g determines the steady-state share of good 1 in total government spending while, for simplicity, the elasticity of substitution between the two goods, μ is the same as for households. The government budget constraint (in real terms) is:

$$b_t + \tau_t\left(w_t^b n_t^b + w_t^p n_t^p + r_{1,t}^k \tilde{k}_{1,t} + r_{2,t}^k \tilde{k}_{2,t}\right) = \frac{p_{g,t}}{p_t} g_t + T_t + (1 + r_{t-1})\frac{b_{t-1}}{\pi_t}\,,$$

where $p_{g,t} = \left(\zeta_g \cdot p_{1,t}^{1-\mu} + (1-\zeta_g) \cdot p_{2,t}^{1-\mu}\right)^{1/(1-\mu)}$ is the price index of government spending and g_t is described by the AR(1) process

$$\log g_t = (1-\rho_g)\log g + \rho_g \log g_{t-1} + \varepsilon_t^g , \tag{11}$$

where ε_t^g is *i.i.d.* and follows a Gaussian distribution $N(0, \sigma_{\varepsilon^g}^2)$. For a given g_t, the government determines its purchases of goods 1 and 2 such as to minimize purchasing costs. The income tax rate is kept constant at its steady-state level, $\tau_t = \tau$ and government spending shocks are contemporaneously financed by adjustments in government debt. In order to guarantee the stability of government debt, transfers follow the rule $\log(T_t) = (1-\rho_T)\log(T) + \rho_T \log(T_{t-1}) - \gamma_b \cdot (b_{t-1} - b)/y$, where the parameter γ_b is positive and sufficiently large.

Monetary policy is described by the augmented Taylor rule

$$\log\left((1+r_t)/(1+r)\right) = \delta_\pi \log(\pi_t/\pi) + \delta_y \log(y_t/y) + \delta_g \log(g_t/g) , \tag{12}$$

where the parameters $\delta_\pi > 1$ and $\delta_y \geq 0$ measure the responsiveness of the nominal interest rate to consumer price inflation and aggregate output, respectively. Aggregate output y_t is defined as $y_t = (p_{1,t}/p_t)y_{1,t} + (p_{2,t}/p_t)y_{2,t}$. Following Nakamura and Steinsson (2014), the nominal interest rate may also directly respond to government spending, with responsiveness measured by δ_g.

Goods market clearing requires aggregate production in industry s, $y_{s,t}$, to be equal to aggregate demand for industry-s good which includes industry-specific resources needed for capital utilization, price adjustment, and labor adjustment:

$$\begin{aligned} y_{s,t} = {} & c_{s,t} + i_{s,t} + g_{s,t} + e(u_{s,t})k_{s,t-1} + \frac{\psi}{2}\left(\frac{p_{s,t}}{p_{s,t-1}} - 1\right)^2 \\ & + \frac{\kappa_{n,s}}{2}\left[\left(\frac{n_{s,t}^b}{n_{s,t-1}^b} - 1\right)^2 + \left(\frac{n_{s,t}^p}{n_{s,t-1}^p} - 1\right)^2\right] y_{s,t} , \qquad s = 1,2 . \end{aligned} \tag{13}$$

5.2 Analytical results from a simplified model version

Before we analyze the effects of an expansion in government spending in the full model, we collapse our baseline model to a one-industry economy (i.e., $\zeta = \zeta_g = \aleph_o = 1$, $y_{2,t} = c_{2,t} = i_{2,t} = u_{2,t} = k_{2,t} = n_{2,t}^b = n_{2,t}^p = 0$) to understand the mechanism driving the response of the pink-collar to blue-collar employment ratio *within* industries. While different employment dynamics between industries affect relative occupational employment rather mechanically, studying analytically the within-industry effect in a simplified model is useful for improving intuition about occupational employment dynamics.

To derive analytical results, we simplify the model by applying the parameter restrictions $\rho_a = \rho_g = \rho_s = 0$, $\delta_y = 0$, $\delta_g = 0$, $\kappa_i \to \infty$, $\delta = 0$, $\gamma_g = 0$, $\sigma \to 1$, $\chi \to 0$, $\kappa_n = 0$, and $\theta \to 1$, which imply that there is no autocorrelation of shocks or fiscal policy, no output reaction of monetary policy, no feedback effect from debt on government spending, a constant stock of physical capital, log utility, no wealth effect on labor supply, no labor adjustment costs, and a degree of substitutability between the composite input, v_t, and pink-collar labor normalized to unity. To facilitate the exposition, we further apply the simplifying restrictions $\gamma = \alpha = 1/2$, $\eta = 1$, and normalize the steady-state values of all input factors to one which also implies $y = 1$. The normalizations of the Frisch elasticity η and the elasticity of substitution between pink-collar labor and the composite input θ imply that capital services are in more elastic supply than labor if $\Delta > 1$ and that blue-collar labor is the closer substitute to capital services than pink-collar labor if $\phi > 1$.

Applying these simplifications and log-linearizing the equilibrium conditions allows to express the output reaction to fiscal shocks as

$$\widehat{y}_t = \Lambda^{-1} \cdot \Xi \cdot g \cdot \widehat{g}_t \,, \tag{14}$$

where hats indicate log deviations from steady state and $\Lambda = \Gamma \cdot \Pi + \Xi/\varepsilon > 0$, $\Xi = \Delta^{-1} + 3\phi + 5\Delta^{-1}\phi + 7 > 0$, $\Gamma = \delta_\pi \cdot \kappa \cdot \lambda^{-1} > 0$, $\Pi = 3\Delta^{-1} + \phi + 7\Delta^{-1}\phi + 5 > 0$, and $\kappa = (\varepsilon - 1)/\psi > 0$ is the slope of the linearized Phillips curve, see Appendix D.2 for a detailed derivation. An increase in government spending raises output as long as prices are not perfectly flexible, i.e., $\psi > 0$. Then, also both types of employment and hence aggregate employment increase if $\widehat{g}_t > 0$, see Appendix D.2.

Our primary focus is on the reaction of the ratio of pink-collar to blue-collar employment to government spending shocks, as in our empirical analysis. In log-linear terms, this reaction is described by

$$\widehat{n}_t^p - \widehat{n}_t^b = \frac{2}{\Lambda \cdot \Delta} \cdot (\Delta - 1) \cdot (\phi - 1) \cdot g \cdot \widehat{g}_t. \tag{15}$$

The pink-collar to blue-collar employment ratio rises in response to a fiscal stimulus if the supply of capital services is relatively elastic compared to the supply of labor ($\Delta > 1$) and if blue-collar labor is a closer substitute to capital services than pink-collar labor ($\phi > 1$). If the former condition is fulfilled, firms raise their use of capital services more than employment since capital services become cheaper relative to labor. This relative price shift occurs because the increase in factor demands after the spending expansion leads to a relatively stronger price increase for the production factor that is supplied less elastically, which is labor. If also the condition $\phi > 1$ is fulfilled, firms raise their demand for blue-collar labor by less than their demand for pink-collar labor due to the relatively high substitutability between capital services and blue-collar labor. As a result, the pink-collar to blue-collar employment ratio rises, corresponding to a pink-collar job boom.[14]

5.3 Numerical results

While the results of the previous section help to understand the within-industry effect of government spending expansions on the pink-collar to blue-collar employment ratio, we now investigate the effects of government spending expansions in a calibrated version of our two-industry economy which also incorporates the between-industry effect that we have documented empirically. Rather than matching the exact profiles of the estimated impulse responses from the empirical VAR model, our aim is to investigate whether the calibrated model generates impulse responses that are generally consistent with our empirical evidence. In particular, we use the calibrated model to quantify how much of the rise in the pink-collar to blue-collar employment ratio is explained by within-industry dynamics and how much can be attributed to between-industry dynamics.

Calibration. The parametrization is a combination of using empirical estimates for the U.S. from the literature for some parameters and calibrating others. Time is measured in quarters. We set the elasticity of substitution in consumption, σ, to 1, a value commonly used in the literature. The weights on labor in the utility function are chosen to imply a steady-state ratio of $n^p/n^b = 1.83$, consistent with its sample mean in our CPS data. The wealth elasticity, investment adjustment

[14] $\Delta < 1$ and $\phi < 1$ would deliver the same result for $\widehat{n}_t^p - \widehat{n}_t^b$ but appears rather unreasonable empirically.

costs, and the elasticity of capital utilization are set to the estimates in Schmitt-Grohé and Uribe (2012). Specifically, we set $\chi = 0.0001$ implying a near-zero wealth elasticity of labor supply. In Appendix D.3, we also show robustness of our results for two alternative values of the wealth elasticity, $\chi = 0.5$ and $\chi = 1$. The parameter of the investment adjustment cost function is set to $\kappa_i = 9$ and the elasticity of capital utilization $\Delta = \delta_1/\delta_2$ is set to 3. The parameter η, which is equal to the Frisch elasticity of labor supply if χ approaches zero, is set to 0.72, as estimated by Bredemeier, Gravert, and Juessen (2019).

The quarterly capital depreciation rate, δ, and the discount factor, β, are calibrated to imply an aggregate capital to output ratio of 4 and an annualized real interest rate of around 3 percent. This delivers $\delta = 0.022$ and $\beta = 0.9927$. The degree of labor mobility across sectors is set to $\omega = 1$, which is in line with the value estimated for the U.S. by Horvath (2000). The elasticity of substitution in consumption between the goods of both sectors is set to $\mu = 1$. The elasticity of substitution between goods within an industry is set to $\epsilon = 6$, which implies a steady-state markup of prices over marginal costs equal to 20%, a value commonly used in the literature. We parameterize the cost of price adjustment, ψ, so as to generate a slope of the Phillips curve consistent with a probability of adjusting prices in the Calvo model equal to 1/3, as estimated by Smets and Wouters (2007). This delivers $\psi \approx 30$ and thus $\kappa \approx 0.17$. The steady-state share of government spending in total output is set to $g/y = 0.196$, its sample mean in our data. The steady-state tax rate and the annualized steady-state debt to GDP ratio are set to $\tau = 0.28$ and $b/(4y) = 0.63$, as calculated by Trabandt and Uhlig (2011). The responsiveness of government transfers to changes in government debt is calibrated to $\gamma_{sb} = 0.1$ to ensure debt sustainability. The autocorrelation of the exogenous processes is set to $\rho_j = 0.9$ for $j = a, g$. The coefficients of the Taylor rule measuring the responsiveness of the interest rate to inflation and output, respectively, are set to $\delta_\pi = 1.5$ and $\delta_y = 0.5/4$, as proposed by Taylor (1993). The parameter δ_g, which captures the responsiveness of the nominal interest rate to government spending, is calibrated to match the estimated impact government spending multiplier of 1.17. We impose a zero net inflation steady state, that is $\pi = 1$.

We set the share parameters $\aleph^p$, $\aleph^b$, α_1, α_2, γ_1, γ_2, and ζ to match steady-state ratios consistent with sample means in the data. We target a steady-state labor income share of 67%, a pink-collar to blue-collar wage ratio in steady state of 0.86 and steady-state distributions of occupations over industries given by $n_1^p/n_2^p = 3.6$ and $n_b^1/n_2^b = 1/3$. Moreover, steady-state output is normalized to $y = 1$, relative prices are assumed to be identical in the long run, i.e. $p_1/p = p_2/p$, and industry outputs are normalized to be of the same size, i.e. $y_1 = y_2$. These calibration targets and normalizations are achieved if we set $\zeta = 0.48$. $\aleph^p = 0.78$, $\aleph^b = 0.25$, $\alpha_1 = 0.23$, $\alpha_2 = 0.78$, $\gamma_1 = 0.33$, and $\gamma_2 = 0.4$. Hence, in our calibration, industry 1 represents the average pink-collar intensive industry, while industry 2 represents the average blue-collar intensive industry. We use the average share of purchased services in government consumption (excluding wage-bill expenditures) of 72% as a target for calibrating the share of the pink-intensive industry good in steady-state government spending, ζ_g.[15]

We determine the elasticities of substitution between production factors, ϕ and θ, to match two targets. First, we use our empirical estimate for the response of relative occupational wage rates following fiscal shocks. Our VAR suggests that, on impact, relative pink-collar wages increase on average by 1%. Second, to discipline our analysis, we target an average elasticity of substitution between capital services and labor of one, as in the canonical Cobb-Douglas case. Our model matches these targets when we set $\phi = 2.7$ and $\theta = 0.07$. This calibration implies that capital services and blue-collar labor are rather close substitutes in production and that pink-collar labor and capital services are complements.

The parameters governing the size of labor adjustment costs in both industries, $\kappa_{n,1}$ and $\kappa_{n,2}$ are set to match two targets. First, we use our empirical evidence on the response of relative sectoral employment following fiscal shocks. Our VAR suggests that employment in pink-collar intensive industries rises by around 0.7 percent more than employment in blue-collar intensive industries. Second, we target a weighted average of labor adjustment costs of 1.85, as estimated by Dib (2003). Our model matches these targets when we set $\kappa_{n,1} = 1.03$ and $\kappa_{n,2} = 3.33$.[16]

[15] This number is calculated for the years 1990-2015 for which the respective NIPA data are available. An alternative would be to include both, government wage payments (as spending in pink-collar intensive industries) and government investment (as spending in blue-collar intensive industries). This would yield a similar share of government spending in pink-collar intensive industries of about 70%.

[16] Hall (2004) provides evidence for substantial heterogeneity in labor adjustment costs between industries. Further, high shares of blue-collar workers in an industry tend to coincide with rather rigid institutional settings such as high unionization rates. In 2014 and 2015, among all major occupation groups, the unionization rates were highest in the four blue-collar major occupations and the major industries with the highest unionization rates in the private sector were transportation and utilities, construction, and manufacturing all of which employ blue-collar occupations disproportionately (source: BLS: Union affiliation of employed wage and salary workers by occupation and industry, 2014-2015 annual averages).

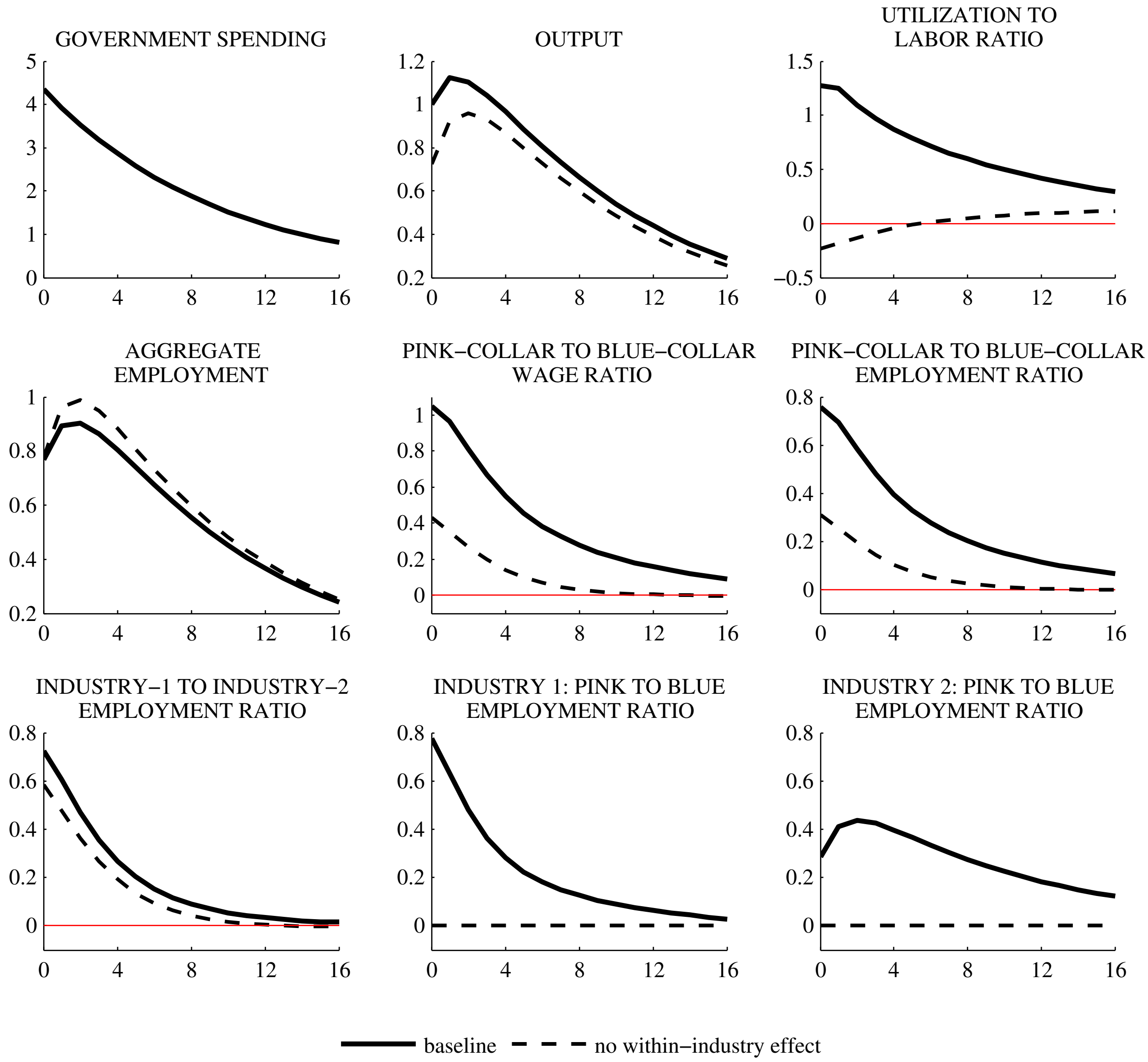
Impulse responses. Figure 10 shows impulse responses to a government spending shock. As for the empirical impulse responses, we normalize the size of the innovations so as to generate an impact change in output by one percent. Responses are expressed in percentage terms. Solid lines display impulse responses of the baseline model, dashed lines show responses of a counterfactual analysis in which we switch off within-industry occupational employment dynamics and thus capture pure between-industry effects.

The solid lines in Figure 10 reveal that our model replicates our key empirical results well. The size of the spending impulse, its impact output effect, and the resulting immediate change in relative occupational wage rates are targeted moments and hence the model matches the empirical evidence with respect to these variables. The remaining, non-targeted, variables are also matched reasonably well. While the model does not match the exact shapes of the empirical impulse responses, in particular, some of the observed hump-shaped patterns, the model is successful in matching the sign and the size of the empirical responses. Aggregate employment rises by roughly the same amount as in the data. Capital utilization increases relative to total labor input by about 1.3%, similar to what is observed in the data. Hence, the model generates an environment with realistic aggregate responses to fiscal shocks wherein we can study occupational employment dynamics.

Most importantly, the middle right panel of Figure 10 shows that fiscal expansions trigger a pink-collar job boom, i.e., employment in pink-collar occupations rises more strongly than employment in blue-collar occupations. Quantitatively, our calibrated model generates a rise in relative pink-collar employment by about 0.76 percentage points, or roughly three quarters of the empirical effect shown in Figure 4. In the model, the relative pink-collar employment boom is due to a combination of a composition effect due to heterogeneous employment changes between industries (lower left panel of Figure 10) and occupation-specific within-industry employment shifts (lower middle and lower right panels of Figure 10), as discussed before.

The calibrated model allows us to disentangle the between-industry (composition) effect and the within-industry (factor substitution) effect and to assess their quantitative importance. To do so, we perform a counterfactual evaluation where we switch off all changes in relative occupational employment within industries by setting the elasticities of substitution in production to

Figure 10: Model-implied effects of government spending shocks.



Notes: Model-implied impulse responses to a rise in government spending. Responses are expressed in percentage terms. On the horizontal axes, the horizon is given in quarters. The size of the spending innovation is normalized such that the response of output is one percent on impact.

zero, $\phi = \theta = 0$. Hence, all remaining dynamics in relative occupational employment reflect heterogeneous employment dynamics between industries and the resulting composition effect. The dashed lines in Figure 10 show that between-industry dynamics contribute a substantial part to the overall rise in relative pink-collar employment. Without within-industry effects, the model predicts relative pink-collar employment to rise by about 0.3 percentage points, i.e., somewhat less than half the total effect. Taking also the within-industry effect into account (going from the dashed to the solid lines) is a quantitatively important improvement in terms of the predicted rise in relative pink-collar employment. Further, a model without within-industry effects has some counterfactual implications. First, by construction, such a model does not generate the empirically observed increases in relative pink-collar employment within industries. Second, such a model version counterfactually predicts capital utilization to fall relative to labor (reflecting different investment dynamics between industries).

In sum, our model suggests that heterogeneous occupational employment dynamics after fiscal expansions can be understood as a combination of composition effects due to heterogeneous employment dynamics across industries and occupation-specific within-industry employment shifts due to differences in the substitutability between capital and labor. In line with our empirical evidence, both effects explain about half of the total effect of fiscal policy on relative occupational employment.

5.4 Discussion

In this section, we first discuss how our explanation squares with the unconditional moments of employment by occupation that we have discussed in Section 2.1. Second, we discuss how our empirical results with respect to white-collar employment relate to our model.

Unconditional moments. We have shown that government spending expansions induce a rise in the pink-collar to blue-collar employment ratio through between-industry and within-industry effects. Thus, conditional on government spending shocks, pink-collar employment is more volatile than blue-collar employment. Yet, as discussed in Section 2.1, blue-collar employment exhibits a stronger unconditional volatility than pink-collar employment. These patterns are not contradictive. In our model, other shocks induce employment dynamics favoring blue-collar occupations. As an example, consider a favorable labor productivity shock. This shock induces firms to substitute away from capital services toward employment leading to a within-industry shift toward blue-collar labor due its higher substitutability with capital services. Figure A15 in Appendix D.3 shows that, in our model, a favorable labor productivity in fact leads to stronger employment growth for blue-collar workers relative to pink-collar workers, making blue-collar employment conditionally more volatile than pink-collar employment, and thus induces opposite dynamics compared to the government spending shock.[17]

Note that our reasoning does not necessarily imply that all demand shocks trigger shifts toward service, sales, and office occupations and that the high unconditional volatility of blue-collar employment is only driven by supply shocks. In our two-industry model, we could consider changes in preferences toward the blue-collar intensive industry good that induce between-industry employment dynamics lowering the pink-collar to blue-collar employment ratio through a composition effect. In an extended model set-up in which a pink-collar intensive sector produces consumption goods and a blue-collar intensive sector produces investment goods, a similar composition effect occurs if there is a disproportionate change in the demand for investment goods as, for example, in response to an investment-specific technology shock.[18]

White-collar occupations. Autor and Dorn (2013) consider three types of labor, “routine-manual” (essentially blue-collar), “non-routine cognitive” (essentially white-collar), and “non-routine manual” (essentially pink-collar) labor. Their set-up implies that pink-collar labor is the least substitutable with capital and blue-collar labor the most. The substitutability of white-collar labor with capital lies in between. Through the lens of our theoretical mechanism, this ordering of the substitutability with capital by occupation group implies that firms should also expand their demand for white-collar labor relative to blue-collar labor, but not as strongly as for pink-collar labor. In fact, we see some indications that white-collar employment tends to increase relative to blue-collar employment. While the increase in white-collar employment relative to blue-collar employment is estimated very imprecisely, we do find a clear increase in relative white-collar wage rates (see Figure A13 in Appendix C.8). This shows that there is indeed the boost in firms’ demand for white-collar labor relative to blue-collar labor which our mechanism suggests should be there given the ordering of the elasticities of substitution discussed above. Further, the responses of relative white-collar total hours (see Figure A13 in Appendix C.8) align much better with the model predictions than those of white-collar employment head counts. Our model does not make a prediction whether firms use the extensive or the intensive margin to satiate their increased demand for labor in a given occupation group, as we find the same pink-collar relative to blue-collar

[17] In Appendix D.3, we show this result analytically in the simplified model version.

[18] We follow Smets and Wouters (2007) in classifying investment-specific technology shocks as demand shocks due to their effect on investment demand.

responses at both margins.

Moreover, for white-collar occupations, other forces seem to be at work that can confound or offset the mechanisms we have identified to be important for relative pink-collar employment. Specifically, we find strong increases in relative white-collar employment within women but not within men (see Figure A13). By contrast, we find similar dynamics in pink-collar to blue-collar employment ratios within groups of workers with similar characteristics, including gender. Our model that does not distinguish between different types of workers beyond occupation hence seems less applicable to white-collar employment.

6 Conclusion

In this paper, we have documented pronounced differences in the occupational employment effects of government spending shocks. Fiscal expansions trigger a pink-collar job boom, i.e., a disproportionate increase in the employment of service, sales, and office occupations relative to aggregate employment. In contrast, we find no discernible employment changes for blue-collar occupations. We have shown that occupation-specific shifts in labor demand are responsible for the heterogeneous employment dynamics. We have presented a business-cycle model that explains the heterogeneous occupational employment dynamics as a consequence of a composition effect due to heterogeneous employment changes across industries and within-industry changes in the occupation mix due to occupational differences in the short-run substitutability between capital services and labor. In our model, fiscal expansions induce a rise in pink-collar relative to blue-collar employment, in line with what we found in the data.

Our results have implications for the discussion about the effects of fiscal policy on inequality. De Giorgi and Gambetti (2012) and Anderson, Inoue, and Rossi (2016) study the distributional consequences of government spending expansions, focusing on consumption rather than on labor-market outcomes. Their results show that fiscal policy raises foremost the consumption of poorer households. Anderson, Inoue, and Rossi (2016) point toward borrowing constraints as an explanation for these results. Our results imply a complementary role of relative labor-market outcomes since we document that employment and labor earnings shift in favor of pink-collar occupations, which are on average relatively low-pay.

Another implication of our results arises from the fact that, in general, blue-collar occupations are most strongly affected by cyclical employment fluctuations (see, e.g., Hoynes, Miller, and Schaller, 2012). Thus, our results imply that countercyclical fiscal policy, while stabilizing aggregate employment in recessions, de-stabilizes the composition of employment. An episode where we believe this is particularly relevant is the Great Recession and its aftermath. Blue-collar workers suffered most strongly from job losses in 2008 and 2009 because they are over-represented in industries where most jobs were cut. Afterwards, blue-collar workers benefitted the least from the (slow) job growth in the recovery. In 2009, the government responded to the recession by enacting the ARRA fiscal stimulus package.[19] The purpose of the ARRA stimulus was, first, to "preserve and create jobs and promote economic recovery" and, second, to "assist those most impacted by the recession" (see the statement of purpose in the ARRA bill). These were predominantly blue-collar workers. We are aware of the limits of applying our findings related to government spending shocks to the ARRA stimulus, which also included changes in taxes and transfers and was conducted in exceptional times. With these caveats in mind, it is nevertheless worth noting that our results imply that part of the jobless recovery in blue-collar employment is due to blue-collar jobs being left out of the jobs created by the government spending expansion.

A final implication of our results relates to long-run trends in the employment and income distribution. There is a downward trend in the employment possibilities of blue-collar workers which is mostly attributed to technological developments and globalization (see, e.g., Acemoglu and Autor, 2011 and Autor and Dorn, 2013). This, in turn, is associated with a secular decline in relative income of blue-collar workers and income polarization. Jaimovich and Siu (2012) and Hershbein and Kahn (2016) have shown that the decline in relative blue-collar employment appears to happen foremost in recessions. Our results suggest that countercyclical fiscal policy contributes to this observation.

Note that our main results apply to the broad body of all government expenditures. However, this does not imply that all fiscal-policy measures necessarily benefit mainly pink-collar workers as

[19]The American Recovery and Reinvestment Act (ARRA) of 2009, also called the Recovery Act or the Obama stimulus, was a fiscal stimulus package by the U.S. federal government of approximately $800 billion to counteract the Great Recession. The stimulus was a broad mix of expansionary fiscal policy including spending on infrastructure, science, education, and health care as well as tax cuts and "fiscal relief" measures for state and local governments which were used to avoid spending cuts and/or tax increases.

we have shown for the average spending expansion. It is plausible that specific measures directly targeted at industries employing high shares of blue-collar workers can induce industry-specific employment dynamics that may outweigh the occupational employment dynamics within industries such that, in total, blue-collar workers benefit disproportionately. Hence, if policy makers want to promote employment possibilities for blue-collar workers, this may be achieved with infrastructure programs or measures targeting specific industries such as the "Cash for Clunkers" program. However, our results indicate that most government spending expansions in recent decades have not been of this type.

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