Fiscal Policy and Occupational Employment Dynamics

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January 2017

Abstract

We document substantial heterogeneity in occupational employment dynamics in response to government spending shocks. Employment rises most strongly in service, sales, and office ("pink-collar") occupations. By contrast, employment in blue-collar occupations is hardly affected by fiscal stimulus which is striking in light of its strong exposure to the cycle and its long-run decline due to technical change and globalization. We provide evidence that occupation-specific changes in labor demand are key to understand these findings and develop a business-cycle model that explains the heterogeneous occupational employment dynamics as a consequence of 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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Support from German Science Foundation (DFG) through SFB 823 is gratefully acknowledged.

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, or 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 to fully understand the aggregate effects of fiscal policy. For example, if a policy intervention redistributes income to households with an above-average marginal propensity to consume, redistribution itself offers a channel through which policy affects macroeconomic aggregates. Since labor earnings are an important part of income for most households, this channel is particularly relevant for policies that have heterogenous effects on employment possibilities across the population. Against this background, an empirical literature, reviewed below, is showing substantial interest in the disaggregated effects of fiscal policy (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).[1]

In this paper, we document substantial heterogeneity in the effects of fiscal policy on the labor market. Empirically, we find important differences in occupational employment dynamics in response to government spending shocks. We provide evidence that occupation-specific changes in labor demand are key to understand heterogenous employment dynamics and present a theoretical explanation based on differences in the substitutability between labor and capital services across occupations in the framework of a business-cycle model.

In our empirical analysis, we estimate vector-autoregressive models (VARs) on U.S. data including occupational employment data from the Current Population Survey (CPS). We focus on a classical fiscal-policy scenario: an unexpected increase in government spending, identified through

[1] Theoretical papers on fiscal policy and heterogeneity include, 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).

a recursive identification scheme with government spending ordered first, taking into account possible anticipation effects due to fiscal foresight using spending forecasts of professional forecasters, following, e.g., Auerbach and Gorodnichenko (2012).

We show that, in response to government spending shocks, employment rises disproportionately in service, sales, and office – so called "pink-collar" – occupations. By contrast, we find no discernible employment changes for production, construction, transport, and installation ("blue-collar") occupations. This implies, together with the rise in aggregate employment, that the share of blue-collar employment in total employment falls significantly. Employment in management, professional, and related ("white-collar") occupations rises as well but more or less proportionately with aggregate employment. Thus, the most substantial change in the employment distribution induced by fiscal policy is a shift from blue-collar to 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.

We show that our findings are a robust feature of the data by conducting a series of robustness checks including different identification schemes, detrending methods, and sample periods. Most importantly, we provide evidence that the documented heterogeneity in occupational employment dynamics is not simply a consequence of heterogeneity in industry-specific employment dynamics or of an expansion in public-sector employment. We further document that the effects of fiscal policy on other labor-market outcomes mirror those we document for employment. In particular, we find that also hours and wage rates in pink-collar occupations rise relative to those in blue-collar occupations. The co-movement between relative occupational employment and relative occupational wages reveals that labor-demand forces shape occupational differences in labor market outcomes.

To explain the documented occupational labor market dynamics, we embed occupational labor with varying degrees of substitutability to capital services (similar to Autor and Dorn 2013) into an otherwise standard New Keynesian business-cycle model. The 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 more than proportionately with output due to changes in relative factor costs in favor of capital use compared to labor. 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. As a consequence, 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 is found in the data.

Our results concerning the heterogenous employment effects of fiscal policy are particularly remarkable in the light of other heterogeneous patterns in occupational employment. It is well known that blue-collar workers are hit hardest by cyclical job losses mostly due to their strong connection to disproportionately cyclical industries like manufacturing and construction (see, e.g., Hoynes, Miller, and Schaller 2012). The same group of workers also suffered the most from job losses due to technical change and globalization (see, e.g., Acemoglu and Autor 2011). In fact, the share of blue-collar employment in total employment sharply decreased over the last decades. It has also been shown that this development has an important cyclical component as blue-collar job losses appear to happen foremost in economic downturns (e.g., Jaimovich and Siu 2012, Hershbein and Kahn 2016). According to our evidence, the same group of workers benefits the least from fiscal stimulus in the sense that government spending hikes hardly create improved employment opportunities within blue-collar occupations such that unemployed blue-collar workers, e.g., would have to bear the costs of occupation switches.[2] This implies that countercyclical fiscal policy

[2] According to Foote and Ryan (2014), however, middle-skill (blue-collar) workers rarely exit unemployment for either high-skill (white-collar) or low-skill (pink-collar) jobs. In line with this, we do not find evidence for a reduction in

destabilizes the distribution of employment and contributes to the accelerated relative decline of blue-collar employment in recessions.

Our results relate to an average unanticipated spending expansion, as it is common in the literature on the effects of fiscal policy. Specific fiscal policy measures may have different effects, for example, when they are targeted directly at specific industries. In fact, we find evidence that the employment effects of expansions of government investment are less strongly biased towards pink-collar occupations than those of government consumption expansions.

Related literature. We are not the first to study the heterogeneous effects of government spending. Giavazzi and McMahon (2012) explore the effects of a specific spending shock, increases in military spending, on hours worked and consumption of different workers but not considering occupations and instead focusing on industries as well as on demographic and socioeconomic characteristics. Nekarda and Ramey (2011) document heterogeneous effects across industries but abstract from the occupation-mix within industries. We show that occupations are key for understanding heterogenous employment effects of fiscal policy by documenting important heterogeneity in the occupational employment effects within industries and within groups of workers with similar characteristics, e.g. gender. Thus, through the lens of our analysis, the findings of Giavazzi and McMahon (2012) and Nekarda and Ramey (2011) are, at least in part, consequences of occupation-specific employment dynamics because occupations are not distributed evenly across industries and other worker characteristics. 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 towards borrowing constraints as an explanation for these results. Our results indicate 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.

A further related literature explores heterogenous effects of economic policies other than government spending. Cloyne and Surico (2017), Johnson, Parker, and Souleles (2006), and Misra and Surico (2014) document heterogeneous consumption responses to tax changes. Coibion,

the number of unemployed blue-collar workers in response to government spending shocks.

Gorodnichenko, Kueng, and Silvia (2012), Mumtaz and Theophilopoulou (2016), and Gornemann, Kuester, and Nakajima (2016), among others, study heterogenous effects of monetary policy. Coibion, Gorodnichenko, Kueng, and Silvia (2012) document that expansionary monetary policy reduces income inequality and propose an explanation based on labor earnings heterogeneity resulting from unequal income gains. Our paper shows that a similar development occurs after expansionary government spending shocks, which trigger an increase in relative labor income of low-pay pink-collar occupations.

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. In Section 4, we develop a theoretical model explaining our findings. In Section 5, we discuss implications of our results. Section 6 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 fiscal 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). The sample period is 1983Q1 to 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.[3]

Before turning to the estimation of the effects of fiscal policy on employment of these occupation groups, we describe some properties of the occupational employment data which will be important for our subsequent analysis. 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. 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).[4] In our econometric analysis, 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 employment components measured by percentage deviations from log-linear trends. While employment

[3] 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. 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, Foote and Ryan 2014). Our results show that major subcategories of the pink-collar occupation group display similar employment dynamics.

[4] 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.

of all three groups are highly correlated over the business cycle, they differ markedly in terms of volatility.[5] 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.[6] 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, in particular between blue-collar and service, sales, and office occupations, there is a substantial gender segregation. 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 heavily 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 heterogenous 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.

[5] 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.

[6] 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

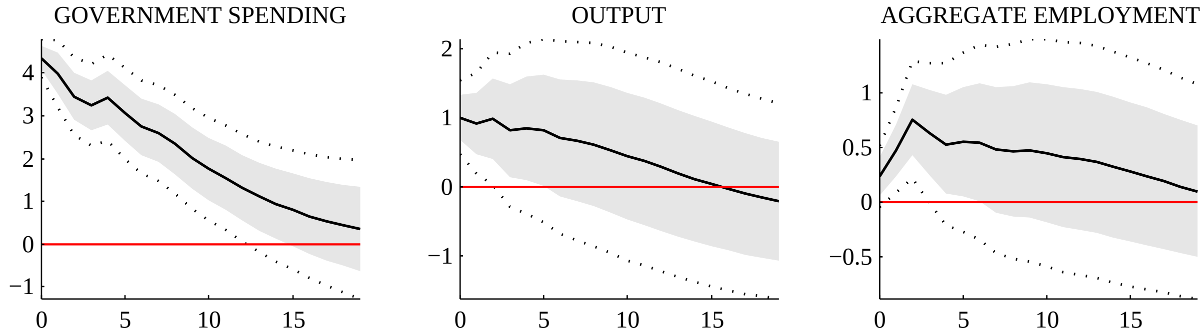
We use a standard approach to identify exogenous variations in government spending by estimating vector-autoregressive models on quarterly U.S. data and using short-run identifying restrictions on the automatic response of government spending to economic activity, following Blanchard and Perotti (2002). Thereby, we take into account anticipation effects of government spending that are found to be important by Ramey (2011b).

Our baseline set of variables consists of government spending (real government consumption and gross investment per capita), output (real GDP per capita), 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, constructed as the annualized difference between the federal funds rate and the log-change in the GDP deflator. 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). 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 different labor market variables of interest in.

Identification of government spending shocks is achieved through a standard recursive identification scheme with government spending ordered first. 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). Ramey (2011b) points out that this identifying assumption is invalid if government spending shocks are anticipated by private agents. To account for anticipation effects, we follow, e.g., Auerbach and Gorodnichenko (2012) and include forecasts from the Survey of Professional Forecasters made at time t for the growth rate of real government purchases for time $t+1$ in the estimation of the VAR. The innovation in government spending orthogonal to the forecast is interpreted as an unanticipated shock to government spending.

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

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



Notes: The solid lines are the impulse responses to a government spending shock. Grey shaded areas and dotted lines show 68 percent and 90 percent confidence bands. The 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.

are measured as deviations from linear trends, we include constants in the VAR and choose a lag length of three.

3 Empirical results

In this section, we first present our main results regarding occupational employment dynamics and corroborate these findings in a series of robustness checks, including alternative identifications of fiscal VARs. Afterwards, we consider further labor-market outcomes such as hours, wages, earnings, and unemployment by occupation. Finally, we provide evidence that occupation-specific changes in labor demand are key to understand the documented employment dynamics.

Before turning to occupational labor market outcomes, we briefly discuss the aggregate effects of fiscal policy. Figure 1 displays the estimated responses of government spending, output, and aggregate employment to a fiscal policy shock.[7] 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 4.2 percent on impact that translates, together with an average share of government spending in GDP in our sample of around 20 percent, into an impact output multiplier of around 1. A government spending expansion also leads to a significant and hump-shaped increase in aggregate employment. These results are well in line with the literature, see, e.g., Ramey (2011a, 2011b), Pappa (2009), and Monacelli, Perotti, and Trigari (2010).

[7]The VAR further includes the real interest rate, tax receipts, the debt-to-gdp ratio, and the spending forecast as control variables.

3.1 Occupational employment dynamics

Our main interest is on the occupational employment dynamics after fiscal policy shocks. The columns of Figure 2 compare the employment effects of fiscal policy for different occupation groups by showing the employment responses in levels (first line) and as shares in total employment (second line). The figure reveals that employment reactions differ markedly across occupations. In particular, the responses of blue-collar employment and employment in pink-collar occupations differ considerably relative to aggregate employment.

Employment in pink-collar occupations increases after a government spending expansion, as does aggregate employment, see the upper left panel of Figure 2.[8] 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.[9] Together with the rise in aggregate employment, this implies that the share of blue-collar employment in total employment declines considerably. Thus, fiscal expansions trigger employment growth particularly for workers in pink-collar occupations, while blue-collar workers do barely benefit from increased employment opportunities in response to a rise in government spending.

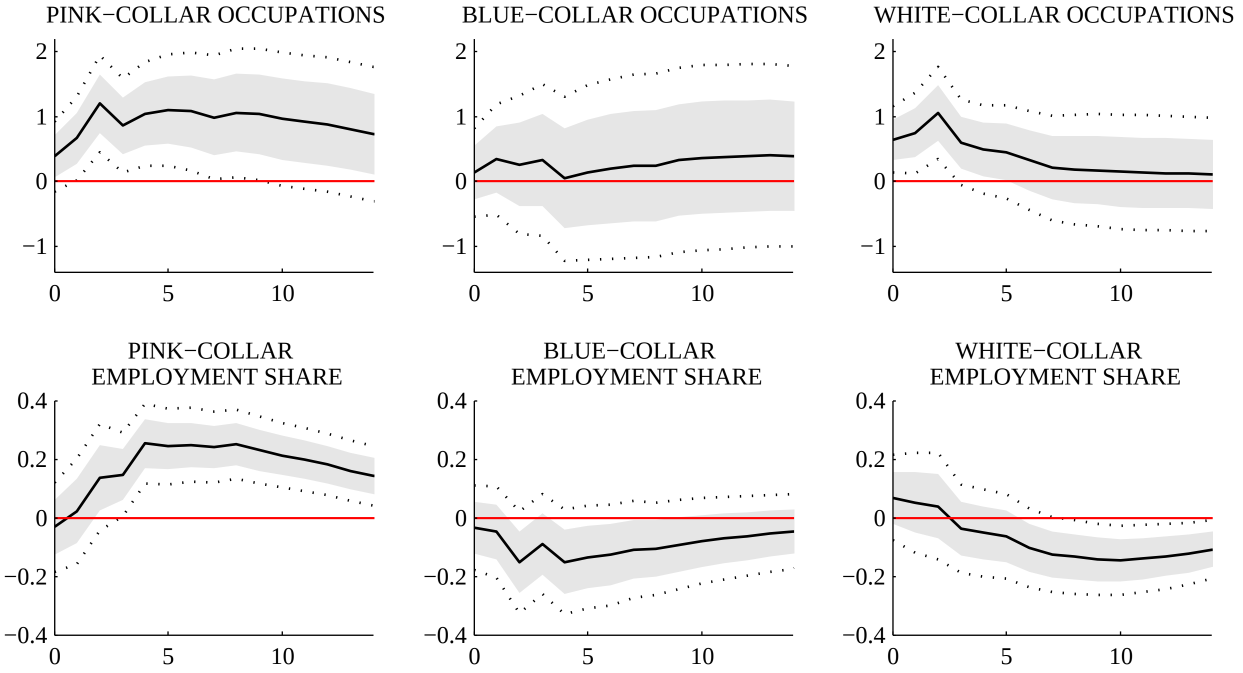
Employment in white-collar occupations also expands after a government spending shock, see the upper-right panel in Figure 2. Note, however, that the increase in white-collar employment is more or less proportionate relative to the rise in economy-wide employment. The response of the share of white-collar employment in total employment is small and indistinguishable from zero for the first 6 quarters; only in the medium run, there is a considerable decline in the white-collar employment share which stems for the more short-lived increase in white-collar employment relative to aggregate employment.

The most substantial finding suggested by Figure 2 is the disproportionate increase in pink-

[8] A similar pattern is found for all three major subcategories of pink-collar occupations, see Figure A1 in Appendix B.1 which shows impulse responses of employment in service occupations, in sales occupations, and in office occupations separately.

[9] Figure A2 in Appendix B.1 shows that there is no significant employment increase in any of the four major occupations in the blue-collar category.

Figure 2: The effects of government spending shocks on employment by occupation.



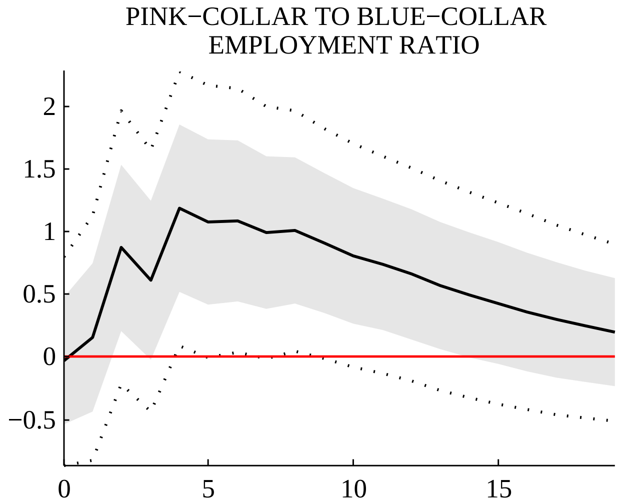
Notes: The solid lines are the impulse responses to a government spending shock. Grey shaded areas and dotted lines show 68 percent and 90 percent confidence bands. The responses are expressed in percentage terms. On the horizontal axes, the horizon is given in quarters. The impact response of output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

collar employment, while there is no discernible change in blue-collar employment. Employment in white-collar occupations behaves similarly to aggregate employment. Taken together, the composition of employment changes towards service, sales, and office occupations. In the following, we concentrate on this shift in the composition of employment from blue-collar employment to employment in pink-collar occupations since it marks the most substantial heterogeneous occupational employment dynamics induced by fiscal policy.

The documented shift in the composition of employment from blue-collar to pink-collar occupations is significant and quantitatively important. This is documented by Figure 3, which shows the response of the ratio of employment in pink-collar occupations to employment in blue-collar occupations and, thus, the relative occupational employment dynamics between these two groups. Employment in service, sales, and office occupations rises by about one percentage point relative to blue-collar employment.

To translate percentage employment changes into jobs, we provide some back-of-the-envelope calculations using the mean responses and the average employment levels by occupation. During

Figure 3: The effects of government spending shocks on pink-collar employment relative to blue-collar employment.



Notes: The solid line is the impulse response to a government spending shock. The grey shaded area and the dotted lines show 68 percent and 90 percent confidence bands. The response is 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.

the first year after an expansionary fiscal shock, employment rises by about 0.5 percent, which corresponds to about 680,000 jobs. Of these additional jobs, 450,000, are jobs in pink-collar occupations, which corresponds to a percentage change of about 0.8 percent. Blue-collar employment rises by only around 0.2 percent which corresponds to around 68,000 new jobs. Relative to the average share of pink-collar workers in total employment of 40 percent, 67 percent of the jobs are created for pink-collar workers. By contrast, only 10 percent of the jobs created by fiscal policy accrue to blue-collar workers. This is considerably below the 25 percent average share of blue-collar workers.

Robustness. Our main finding – expansionary fiscal policy leads to a shift in the composition of employment from blue-collar to pink-collar employment – is not specific to the baseline specification of our VAR but is obtained for a wide range of re-specifications of the empirical model. Two results are noteworthy. First, as discussed before, there is substantial trend heterogeneity in occupational employment and we want to rule out that our results are driven by the way we treat these trends. In Appendix B.2, we document that our results are robust to alternative ways of handling trends in the data. Second, our results are robust to excluding the Great Recession from the data sample (i.e., to re-estimating the model on a sample period that ends in 2006). This is important because our baseline sample includes the ARRA stimulus, which was a large fiscal policy impulse in extraordinary times, and we want to make sure that our results are not solely driven by the observations pertaining to the period of the Great Recession and its aftermath. In Appendix B.2, we show that this is not the case.

Moreover, we show that the documented shift from blue-collar employment to employment in pink-collar occupations is also obtained when we employ alternative identification schemes for government spending shocks. First, we follow Auerbach and Gorodnichenko (2012) and use their alternative approach to control for anticipation effects while identifying unanticipated government spending shocks. Instead of including the forecast for the growth rate of government spending, we augment the VAR with the forecast error for the growth rate of government spending, i.e., the difference between the actual, first-release series and the forecast series. The forecast error is ordered first and the identification scheme is again recursive. In this specification, an innovation in the forecast error is interpreted as an unanticipated spending shock. Second, we identify fiscal shocks using sign restrictions. In particular, we follow Mountford and Uhlig (2009) and Pappa (2009) and identify fiscal shocks by imposing that they raise GDP and the primary budget deficit, and are orthogonal to business cycle shocks that affect GDP and the deficit in opposite directions. Figure A4 in Appendix B.3 displays results of these alternative identification schemes. In both cases, we observe a strong and significant increase in the ratio of pink-collar to blue-collar employment, as in our baseline identification.

A number of researchers argue that it can make a difference whether one considers total government spending or components of government expenditures in fiscal VARs (see, e.g., Ramey 2011b, Ilzetzki, Mendoza, and Végh 2013). To address this, we identify unanticipated and exogenous changes to government investment and government consumption in separate estimations, in which we include the spending category of interest and identify, as in our baseline specification, the respective spending shock via a recursive identification scheme with the spending category of interest ordered first. The effects on the pink-collar to blue-collar employment ratio are found to be stronger for variations in government consumption. Most importantly, we find a significant rise in pink-collar employment relative to blue-collar employment for both components of government spending, see Figure A4 in Appendix B.3. We will come back to this when we discuss implications of our results.

3.2 Further labor market outcomes by occupation

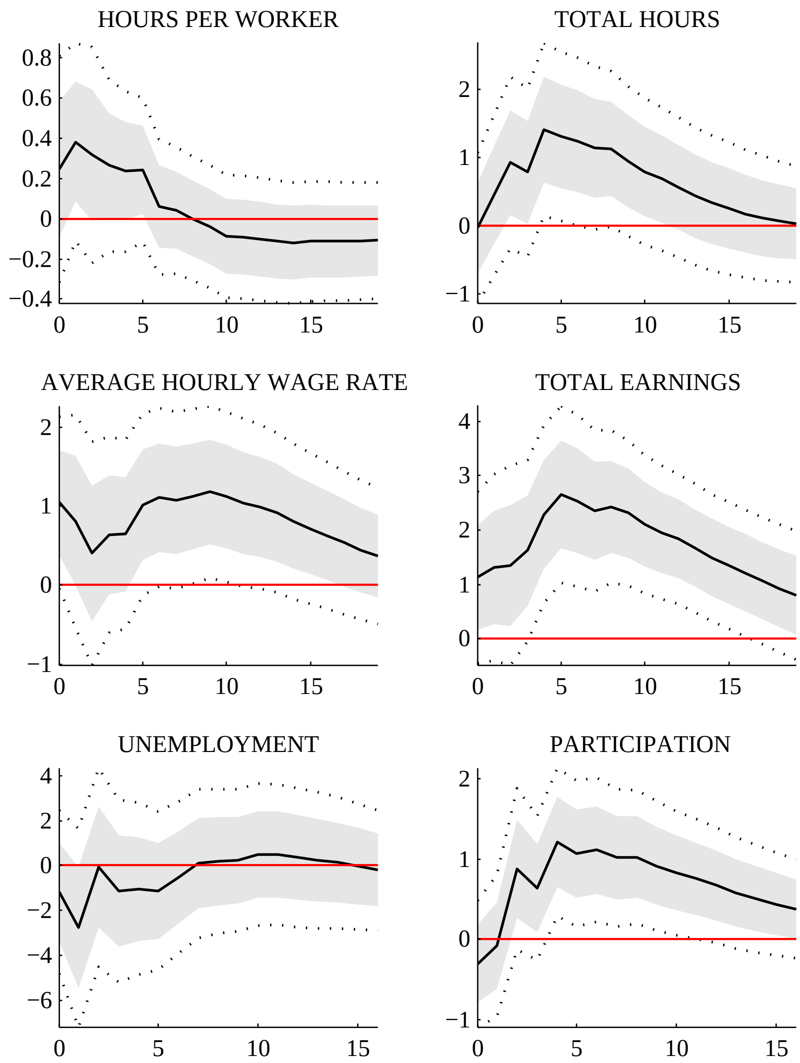
In the previous analysis, we have documented pronounced heterogeneity in the responses of employment by occupation to government spending expansions. In this subsection, we complete our analysis by investigating further labor market outcomes by occupation: hours, wage rates, earnings, unemployment, and labor-force participation. This analysis is important because, first, it allows to fully assess the occupational labor market effects of fiscal policy and, second, it provides guidance for the theoretical model that is developed in Section 4.

Since the most pronounced heterogeneous employment pattern is the shift from blue-collar to pink-collar employment, we concentrate here on the relative dynamics between these two groups, measured by the response of the ratio of pink-collar to blue-collar labor-market outcomes. The upper left panel of Figure 4 shows that, for average hours of a working individual, we find the same qualitative response as for employment in our baseline specification. Hours per pink-collar worker tend to rise relative to hours per blue-collar worker after government spending expansions. This implies that dynamics at the intensive margin of employment reinforce the dynamics at the extensive margin. This is corroborated when we consider total hours worked (upper right panel of Figure 4). As can be seen, total hours worked of pink-collar workers increases relative to blue-collar workers. Quantitatively, the response of the total hours ratio is more pronounced than the response of the employment ratio, again indicating that developments at both the intensive and the extensive margin work in the same direction.

The middle-left panel of Figure 4 shows the response of the relative hourly wage rate. We find that wage rates of pink-collar workers rise relative to those of blue-collar workers. Thus, there is a positive co-movement of relative occupational employment and relative occupational wage rates. This is important because it indicates that occupation-specific changes in labor demand rather than in labor supply are key for understanding the heterogenous occupational employment effects of fiscal expansions.

The middle-right panel of Figure 4 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 towards workers in pink-collar occupations.

Figure 4: The effects of government spending shocks on relative labor market outcomes: pink-collar to blue-collar ratios.



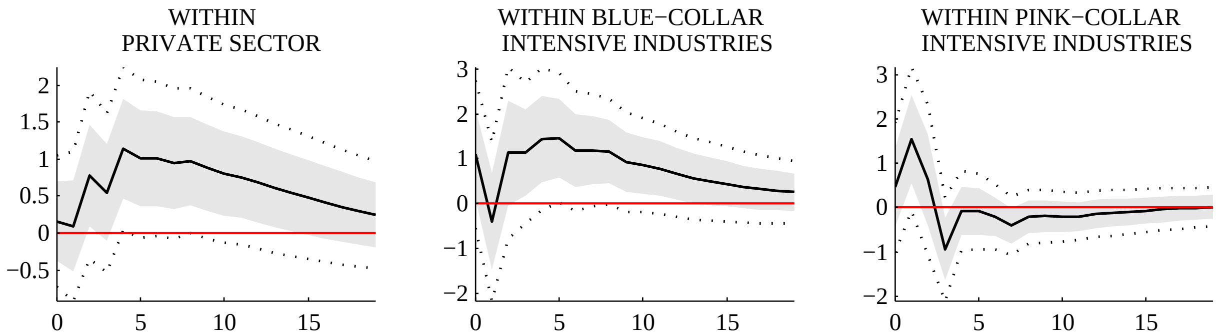
Notes: The solid lines are the impulse responses of the ratio of the respective pink-collar to blue-collar labor market variable to a government spending shock. Grey shaded areas and dotted lines show 68 percent and 90 percent confidence bands. The responses are expressed in percentage terms. On the horizontal axes, the horizon is given in quarters. The impact response of output (not shown) is normalized to one percent. Total hours is the sum of hours worked by individuals in the respective occupation. Total earnings is the sum of labor earnings of individuals in the respective occupation. Hours per worker is total hours worked divided by employment. Average hourly wage rate is total earnings divided by total hours worked. Unemployment is the number of unemployed individuals by occupation of the last job that the unemployed person held. Participation is the sum of employed and unemployed individuals in the respective occupation.

Finally, we investigate the flows into pink-collar jobs induced by fiscal expansions using information on unemployment and participation by occupation from the CPS. Note that, for unemployed individuals, the CPS provides information on the occupation of the last job. Thus, for example, pink-collar unemployment measures the number of unemployed individuals whose last job was in a pink-collar occupation (and not the number of individuals searching for a pink-collar job). The lower-left panel of Figure 4 shows that, in response to government spending expansions, relative pink-collar unemployment tends to fall. The decline in relative pink-collar unemployment indicates that, among individuals working in the additionally created pink-collar jobs, there are relatively more workers whose last job also was in a pink-collar occupation than those whose last job was in a blue-collar occupation. Hence, occupation switches from blue-collar to pink-collar occupations do not seem to be the dominant flow into the additional pink-collar jobs. This evidence of limited occupation switches at business-cycle frequency motivates our modeling of the labor market in terms of stocks rather than flows in Section 4. It is also consistent with Foote and Ryan (2014) who show that middle-skill (blue-collar) workers rarely exit unemployment for either high-skill (white-collar) or low-skill (pink-collar) jobs. Likewise, Fujita and Moscarini (2013) show that unemployed workers often return to their former employers. However, some switches between occupation groups appear to occur as total participation in pink-collar occupations rises relative to blue-collar occupations, see lower right panel of Figure 4. Of course, flows into pink-collar employment induced by fiscal policy may also originate from people who enter the labor market for the first time taking up pink-collar jobs. We will address this point when we take into account information on workers' age in the next section.

3.3 The role of sectors, industries, and workers' characteristics

In this subsection, we present empirical evidence that *occupation*-specific shifts in labor demand are responsible for the heterogenous employment dynamics after government spending expansions that we have documented before. In particular, we rule out that the heterogenous employment dynamics across occupations simply reflect heterogenous employment dynamics across industries or sectors. Moreover, we obtain similar occupational employment dynamics within groups of workers with similar characteristics, which shows that workers' characteristics cannot be the driving force

Figure 5: The effects of government spending shocks on the pink-collar to blue-collar employment ratio in the private sector and in broad industry groups.



Notes: The solid lines are the impulse responses to a government spending shock. Grey shaded areas and dotted lines show 68 percent and 90 percent confidence bands. The 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.

behind the dynamics in the aggregate.

To start with, note that we also observe a shift from blue-collar to pink-collar employment when excluding employees working in the public sector from the analysis. This is important because the government wage bill is a major part of government expenditures and, at the same time, the share of pink-collar occupations in public sector employment is higher than in the economy as a whole. In our sample, the average share of pink-collar workers in public sector employment amounts to 53 percent, as compared to 41 percent economy-wide. The blue-collar share in public sector employment is 6 percent, relative to 21 percent in total employment. Since government employment rises slightly more than aggregate employment in response to fiscal expansions (see Figure A5 in Appendix B.4), the shift from blue-collar employment to employment in service, sales, and office occupations may in part be a consequence of a composition effect due to a disproportionate expansion of government employment. Importantly, though, the left panel of Figure 5 shows that we observe the same heterogenous employment response in the private sector. Also quantitatively, the response is very similar implying that the increase in government employment contributes only to a very limited degree to the overall dynamics of employment by occupation.

Next, we provide evidence that the documented heterogenous occupational employment dynamics are not a simple relabeling of heterogenous employment dynamics across industries. Occupations are not equally distributed among industries. On the one hand, industries such as construction, manufacturing, and transportation are blue-collar intensive compared to the economy as a whole; taking the average of our sample, the blue-collar employment share in these industries is far above 50 percent, relative to 21 percent economy-wide. On the other hand, industries such as financial activities, wholesale and retail trade, as well as leisure and hospitality employ a disproportionate share of service, sales, and office occupation workers. Thus, the disproportionate employment growth in service, sales and office occupations observed in the data may in part be a result of disproportionate employment growth in industries employing workers in these occupations disproportionately. The latter in turn may be a consequence of the high share of services in the government consumption bundle.[10] Likewise, 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, for example, because of the moderate share of government investment in total government spending. In fact, when we estimate the effects of fiscal shocks on employment in different industries, we find evidence for a disproportionate increase in employment of pink-collar intensive industries and a less than proportionate increase in employment of blue-collar intensive industries (see Figure A5 in Appendix B.4). Importantly, though, Figure 5 shows 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 blue-collar intensive industries (middle panel) as well as within pink-collar intensive industries (right panel), as we do in the aggregate.

To corroborate this point, we construct a formal test that allows to reject the hypothesis that our results are solely reflecting between-industry employment dynamics. For this, we construct a hypothetical time series of occupational employment implied only by between-industry dynamics and isolate a residual component of occupational employment unrelated to industries (details can be found in Appendix B.5). Also for the component unrelated to industry dynamics, we find occupational employment effects favoring pink-collar workers. Hence, the documented occupational employment dynamics are certainly not just a consequence of industry dynamics.

Finally, we provide evidence that the heterogenous occupational employment responses to fiscal shocks are due to occupation-specific shifts in labor demand and not due to occupation-specific

[10] From 1999 to 2015, where the respective NIPA data is available, the share of purchased services in total government consumption expenditures averaged at 25%. Excluding the wage bill, the share of purchased services even amounts to 72% on average.

changes in labor supply. First, recall that a fiscal expansion induces a positive co-movement of the employment and wage ratio between pink-collar and blue-collar workers, see the lower-left panel in Figure 4. This suggests that firms increase their demand for service, sales, and office workers by more than their demand for blue-collar workers. Still, there may be different labor-supply reactions across occupation groups due to different workers' characteristics within occupations. For example, genders are not equally distributed among occupations. Women are overrepresented in service, sales, and office occupations while men constitute the majority of workers in blue-collar occupations. It is well documented that women and men have different elasticities of labor supply and different attachments to the labor market. To rule out that gender-specific labor supply factors explain the occupation-specific employment dynamics after fiscal expansions, we re-estimate our model on samples that include only female and only male workers, respectively. Importantly, we find a significant shift towards pink-collar occupations also among female workers as well as among male workers, see the upper panels of Figure A7 in Appendix B.6.

Similar arguments apply for workers in different age groups. For example, it may be that the relative decline in blue-collar employment reflects that new entrants to the labor market specialize in pink-collar (or white-collar) occupations in light of the secular decline in blue-collar employment possibilities and that this trend is accelerated in periods of government spending expansions. To investigate this, we distinguish between young workers (aged below 30) and old workers (aged above 30) and estimate the effects of fiscal policy on relative occupational employment within these age groups. We find that pink-collar employment increases relative to blue-collar employment in both age groups, see the lower panels of Figure A7 in Appendix B.6. The pronounced increase in relative pink-collar employment within the group of workers above 30 indicates that the additional pink-collar jobs are not primarily taken up by individuals who enter the labor market for the first time.

From this, we conclude that occupation-specific shifts in labor demand in favor of pink-collar workers independent of industry or workers' characteristics are key for understanding the documented heterogenous employment dynamics in response to government spending expansions. Pink-collar employment appears to attract individuals in different industries and with different characteristics. This suggests 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, see Section 3.2. In the next section, we build a model explaining these occupation-specific labor-demand forces.

4 Explaining occupational employment dynamics

In order to understand why firms adjust their demand for labor in different occupations differently, it is important to understand what distinguishes pink-collar occupations from blue-collar occupations. 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.[11] 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 will embed differences in the short-run substitutability of capital services with blue-collar and pink-collar labor into an otherwise standard New Keynesian business-cycle model. Our model considers a representative industry wherein we distinguish between labor in pink-collar and blue-collar occupations. This modeling choice is motivated by the importance of occupation-specific factors in explaining employment dynamics both within industries and across all industries, as documented in Section 3.3.

[11] 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, we explain differences in short-run occupational employment dynamics by 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.

The model is able to replicate the empirical evidence on the effects of fiscal shocks on output, aggregate employment, and relative occupational labor market outcomes. The model's mechanism can be described as follows. After a fiscal expansion, firms demand more factor inputs to meet increased product demand. In this process, they raise their demand for capital services more than proportionally with output, in line with our evidence that aggregate employment rises less than proportionate relative to output. In our model, firms behave like this because relative factor costs change in favor of capital use compared to labor. This is the consequence of a relatively elastic short-run supply of capital services compared to labor.[12] 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 increase their demand for pink-collar labor by more than their demand for blue-collar labor, thereby generating a pink-collar employment boom that is associated with a rise in the pink-collar to blue-collar wage ratio, in line with what is found in the data.

4.1 The model

The model economy consists of firms, households, and the government. Firms produce differentiated goods under monopolistic competition and face costs of price adjustment. Production inputs are capital services and different types of occupational labor. Households are families whose members differ by occupation. 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, issues short-term government bonds, pays transfers, and purchases goods for government consumption. A variable without a time subscript denotes its steady-state level.

Firms. There is a unit mass of firms. Each firm $j \in [0,1]$ is a monopolistic supplier of a different variety $y_{j,t}$ of the final good $y_t = \left(\int_0^1 y_{j,t}^{(\epsilon-1)/\epsilon} di\right)^{\epsilon/(\epsilon-1)}$, where $\epsilon > 1$ is the elasticity of substitution between different varieties. Firm j produces its output $y_{j,t}$ using capital services $\tilde{k}_{j,t}$ and two types of labor, blue-collar labor $n^b_{j,t}$ and pink-collar labor $n^p_{j,t}$.

Firm j uses the following nested CES production technology:

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

[12] 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).

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

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

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 $v_{j,t}$ and labor in the representative pink-collar occupation. $\alpha \in (0,1)$ and $\gamma \in [0,1]$ are exogenous parameters, $z > 0$ is total factor productivity, and a_t is labor productivity 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 $i.i.d.N(0, \sigma^2_{\varepsilon^a})$. This production technology resembles the one used by Autor and Dorn (2013).[13] The production function (1) allows for 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 $\tilde{k}_{j,t}$, $n^b_{j,t}$, and $n^p_{j,t}$ to minimize real costs

$$\mathrm{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{\lambda_t}{\lambda_0} \left(w^b_t n^b_{j,t} + w^p_t n^p_{j,t} + r^k_t \tilde{k}_{j,t} + \frac{\kappa_n}{2}\left(\frac{n^b_{j,t}}{n^b_{j,t-1}} - 1\right)^2 y_t + \frac{\kappa_n}{2}\left(\frac{n^p_{j,t}}{n^p_{j,t-1}} - 1\right)^2 y_t \right) , \qquad (2)$$

subject to (1), where w^b_t and w^p_t are real wages for blue-collar and pink-collar labor, respectively, and r^k_t is the rental rate of capital services. 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 last two terms are quadratic labor adjustment costs, expressed in units of the final good, where the parameter $\kappa_n \geq 0$ measures the extent of labor adjustment costs.[14] Let $mc_{j,t}$, the Lagrange multiplier of the firm's cost minimization problem, denote real marginal costs.

The firm faces a quadratic cost of price adjustment. It chooses its price $p_{j,t}$ to maximize the

[13] In their model, there is a CES aggregate of "routine goods production" (blue-collar) labor and capital which is aggregated with "manual services" (pink-collar) labor. In contrast to Autor and Dorn (2013), we abstract from "high skill" labor, as this type of labor moves roughly proportionately with aggregate employment.

[14] Accounting for labor adjustment costs allows the model to generate the delayed hump-shaped responses of aggregate employment and of employment ratios that we observe in the data. Model mechanisms and the qualitative results do not depend on this model feature.

discounted stream of real profits

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

subject to the demand function for variety j, $y_{j,t} = (p_{j,t}/p_t)^{-\epsilon} y_t$, where y_t is aggregate demand, $p_{j,t}/p_t$ is the relative price of variety j, and $p_t = \left(\int_0^1 p_{j,t}^{1-\epsilon} di \right)^{1/(1-\epsilon)}$ is the price index. The final term represents the costs of price adjustment, where $\psi \geq 0$ measures the degree of nominal price rigidity.

Since all firms choose the same prices and quantities in equilibrium, we now drop the index j. The optimal demand for capital services, blue-collar labor, and pink-collar labor are described by the first-order conditions of the cost minimization problem:

$$mc_t \cdot mpk_t = r_t^k, \tag{3}$$

$$mc_t \cdot mpl_t^b = w_t^b + \kappa_n \left(\frac{n_t^b}{n_{t-1}^b} - 1 \right) \frac{y_t}{n_{t-1}^b} - \kappa_n \beta \, \mathrm{E}_t \left\{ \frac{\lambda_{t+1}}{\lambda_t} \left(\frac{n_{t+1}^b}{n_t^b} - 1 \right) \left(\frac{y_{t+1} n_{t+1}^b}{(n_t^b)^2} \right) \right\}, \tag{4}$$

$$mc_t \cdot mpl_t^p = w_t^p + \kappa_n \left(\frac{n_t^p}{n_{t-1}^p} - 1 \right) \frac{y_t}{n_{t-1}^p} - \kappa_n \beta \, \mathrm{E}_t \left\{ \frac{\lambda_{t+1}}{\lambda_t} \left(\frac{n_{t+1}^p}{n_t^p} - 1 \right) \left(\frac{y_{t+1} n_{t+1}^p}{(n_t^p)^2} \right) \right\}, \tag{5}$$

where the marginal products of capital, blue-collar and pink-collar labor are given by

$$mpk_t = \alpha \cdot \gamma \cdot z^{\frac{\theta-1}{\theta}} \left(\frac{y_t}{v_t} \right)^{1/\theta} \left(\frac{v_t}{\tilde{k}_t} \right)^{1/\phi},$$

$$mpl_t^b = \alpha \cdot (1-\gamma) \cdot z^{\frac{\theta-1}{\theta}} \cdot a_t^{\frac{\phi-1}{\phi}} \left(\frac{y_t}{v_t} \right)^{1/\theta} \left(\frac{v_t}{n_t^b} \right)^{1/\phi},$$

$$mpl_t^p = (1-\alpha) \cdot (z \cdot a_t)^{\frac{\theta-1}{\theta}} \left(\frac{y_t}{n_t^p} \right)^{1/\theta}.$$

Optimal pricing behavior is described by the first-order condition of the profit maximization problem:

$$\psi(\pi_t - 1)\pi_t = \psi \beta \, \mathrm{E}_t \left\{ \frac{\lambda_{t+1}}{\lambda_t} \frac{y_{t+1}}{y_t} (\pi_{t+1} - 1)\pi_{t+1} \right\} + \epsilon \left(mc_t - \frac{\epsilon - 1}{\epsilon} \right), \tag{6}$$

where $\pi_t = p_t/p_{t-1}$ is the gross inflation rate and $\frac{\epsilon}{\epsilon-1}$ is the desired price mark-up in the absence of price adjustment costs ($\psi = 0$). The system of first-order conditions for firms differs from a standard model only in that there are two first-order conditions for labor demand. For $\alpha = 0$, the model collapses to the standard case with capital and only one type of labor as input factors.

Households. The economy consists of a continuum of infinitely-lived households, with mass normalized to one. Each household supplies pink-collar and blue-collar labor. We deliberately 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. We consider a unitary household that cares about its total consumption level c_t and receives disutility from both types of labor, n_t^p and n_t^b. We do not distinguish between the extensive margin and the intensive margin of employment. This is supported by the empirical evidence showing that similar developments occur at both margins, see Section 3.2. A representative household maximizes its lifetime utility function

$$\mathrm{E}_0 \sum_{t=0}^{\infty} \beta^t u(c_t, n_t^p, n_t^b), \tag{7}$$

where $u(c_t, n_t^p, n_t^b)$ is the period utility function which, following Jaimovich and Rebelo (2009), 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

$$x_t = c_t^{\chi} x_{t-1}^{1-\chi}, \tag{8}$$

$\chi \in (0, 1]$ 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

$$c_t + i_t + b_t = (1-\tau_t)\left(w_t^p n_t^p + w_t^b n_t^b + r_t^k \tilde{k}_t\right) - e(u_t)k_{t-1} + (1+r_{t-1})\frac{b_{t-1}}{\pi_t} + s_t + d_t, \tag{9}$$

where c_t is consumption, i_t is investment into physical capital that is owned by households, b_{t-1} is the beginning-of-period stock of real government bonds, τ_t is the income tax rate, k_{t-1} denotes the beginning-of-period capital stock, u_t is capital utilization, $e(u_t)$ are the costs of capital utilization,

s_t are government transfers, d_t are dividends from the ownership of firms, and r_t is the nominal interest rate.

Capital evolves according to the following law of motion

$$k_t = (1-\delta)k_{t-1} + \left(1 - \frac{\kappa_i}{2}\left(\frac{i_t}{i_{t-1}} - 1\right)^2\right) i_t \,, \tag{10}$$

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

Households choose the capital utilization rate u_t, which transforms physical capital into capital services $\tilde{k}_t$ according to $\tilde{k}_t = u_t k_{t-1}$. Costs of capital utilization are given by

$$e(u_t) = \delta_1(u_t - 1) + \frac{\delta_2}{2}(u_t - 1)^2 \,, \tag{11}$$

which implies the absence of capital utilization costs at the deterministic steady state in which capital utilization is normalized to $u = 1$. 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, as illustrated below.

Households choose quantities c_t, x_t, b_t, k_t, i_t, u_t, n_t^b, and n_t^p, taking as given prices, dividends, transfers, and taxes w_t^p, w_t^b, p_t, r_t^k, r_t, d_t, s_t, τ_t to maximize (7) subject to (8), (9) and (10). Let λ_t, $q_t\lambda_t$, and ι_t denote Lagrange multipliers on the budget constraint, the capital accumulation equation and the definition of x_t, respectively, where q_t is the shadow value of installed capital. The first-order conditions for consumption, the composite of current and past consumption, bond holdings, capital holdings, investment, capital utilization, and labor supply of both household members, respectively, read

$$\lambda_t = \xi_t + \chi \iota_t \frac{x_t}{c_t} \,, \tag{12}$$

$$\iota_t = -\xi_t \left(\frac{\Omega^p}{1+1/\eta}(n_t^p)^{1+1/\eta} + \frac{\Omega^b}{1+1/\eta}(n_t^b)^{1+1/\eta}\right) + \beta(1-\chi)\,\mathrm{E}_t\left\{\iota_{t+1}\frac{x_{t+1}}{x_t}\right\} \,, \tag{13}$$

$$\lambda_t = \beta\,\mathrm{E}_t\left\{\lambda_{t+1}\frac{(1+r_t)}{\pi_{t+1}}\right\} \,, \tag{14}$$

$$\lambda_t q_t = \beta\, \mathrm{E}_t \left\{ \lambda_{t+1} \left((1-\tau^k_{t+1}) r^k_{t+1} u_{t+1} - e(u_{t+1}) + q_{t+1}(1-\delta) \right) \right\} , \tag{15}$$

$$1 = q_t \left(1 - \frac{\kappa_i}{2} \left(\frac{i_t}{i_{t-1}} - 1 \right)^2 - \kappa_i \left(\frac{i_t}{i_{t-1}} - 1 \right) \frac{i_t}{i_{t-1}} \right) \tag{16}$$

$$+ \beta\, \mathrm{E}_t \left\{ \frac{\lambda_{t+1}}{\lambda_t} q_{t+1} \kappa_i \left(\frac{i_{t+1}}{i_t} - 1 \right) \left(\frac{i_{t+1}}{i_t} \right)^2 \right\} ,$$

$$(1-\tau_t) r^k_t = \delta_1 + \delta_2 (u_t - 1) , \tag{17}$$

$$w^b_t (1-\tau_t) \lambda_t = \Omega^b \left(n^b_t \right)^{1/\eta} x_t \xi_t , \tag{18}$$

$$w^p_t (1-\tau_t) \lambda_t = \Omega^p \left(n^p_t \right)^{1/\eta} x_t \xi_t , \tag{19}$$

where $\xi_t = \left(c_t - \left(\frac{\Omega^p}{1+1/\eta} (n^p_t)^{1+1/\eta} + \frac{\Omega^b}{1+1/\eta} (n^b_t)^{1+1/\eta} \right) x_t \right)^{-\frac{1}{\sigma}}$. The only difference to a standard model is that there are two labor-supply conditions, one for each household member.

Market clearing, monetary and fiscal policy. Monetary policy is described by an interest rate rule of the form

$$\log \left((1+r_t)/(1+r) \right) = \delta_\pi \log \left(\pi_t / \pi \right) + \delta_y \log \left(y_t / y \right) , \tag{20}$$

where the parameters $\delta_\pi > 1$ and $\delta_y \geq 0$ measure the responsiveness of the nominal interest rate to deviations of inflation and output from their steady-state values, respectively.

The fiscal authority faces the following budget constraint (in real terms):

$$b_t + \tau_t \left(w^b_t n^b_t + w^p_t n^p_t + r^k_t \tilde{k}^s_t \right) = g_t + s_t + (1 + r_{t-1}) \frac{b_{t-1}}{\pi_t} .$$

Government spending, g_t, is described by the following process:

$$\log g_t = (1-\rho_g) \log g + \rho_g \log g_{t-1} - \gamma_g \cdot \frac{(b_{t-1} - b)}{y} + \varepsilon^g_t , \tag{21}$$

where ε^g_t is $i.i.d.N(0, \sigma^2_{\varepsilon^g})$ and $(b_{t-1} - b)/y$ denotes previous period's deviation of real debt from its steady state, expressed in terms of steady-state output y. Following, e.g., Corsetti, Meier, and Müller (2012), we allow for a systematic feedback effect of public debt on government spending, captured by the parameter $\gamma_g \geq 0$. The income tax rate is kept constant at its steady-state level, $\tau_t = \tau$. In order to guarantee the stability of government debt, transfers follow the rule $\log(s_t) = (1-\rho_s)\log(s) + \rho_s \log(s_{t-1}) - \gamma_b \cdot (b_{t-1} - b)/y$, where the parameter γ_b is positive and sufficiently large.

Goods market clearing requires aggregate production, y_t, to be equal to aggregate demand which includes resources needed for capital utilization, price adjustment, and labor adjustment:

$$y_t = c_t + i_t + g_t + e(u_t)k_{t-1} + \frac{\psi}{2}(\pi_t - 1)^2 y_t + \frac{\kappa_n}{2}\left(\frac{n_t^p}{n_{t-1}^p} - 1\right)^2 y_t + \frac{\kappa_n}{2}\left(\frac{n_t^b}{n_{t-1}^b} - 1\right)^2 y_t \, . \quad (22)$$

4.2 Analytical results from a simplified model version

We now investigate the effects of an expansion in government spending. We proceed in two steps. First, we consider a simplified version of the model that allows us to provide analytical results. We use this model version to understand the basic mechanism driving the response of the pink-collar to blue-collar employment ratio. Then, we consider a calibrated version of the model and present numerical results.

To facilitate the derivation of analytical results, we simplify the model by applying the parameter restrictions $\rho_a = \rho_g = \rho_s = 0$, $\delta_y = 0$, $\kappa_i \to \infty$, $\delta = 0$, $\gamma_g = 0$, $\sigma \to 1$, $\chi = 0$, $\kappa_n = 0$, 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

$$\widehat{y}_t = \Lambda^{-1}\Xi \cdot g \cdot \widehat{g}_t \, , \quad (23)$$

where hats indicate log deviations from steady state and

$$\Lambda = \Gamma \cdot c \cdot \left(5 + 3\Delta^{-1} + \phi + 7\Delta^{-1}\phi\right) + 7 + 3\phi + \Delta^{-1} + 5\Delta^{-1}\phi$$
$$- 8\delta_1 (1+\phi) - c \cdot \Big(8\left(1 + \Delta^{-1}\phi\right)\Omega^b + 2\left(3 + \Delta^{-1} + \phi + 3\Delta^{-1}\phi\right)\Omega^p\Big),$$

$\Xi = \Delta^{-1} + 3\phi + 5\Delta^{-1}\phi + 7$, $\Gamma = \delta_\pi \cdot \kappa \cdot \lambda^2 > 0$, and κ is the slope of the linearized Phillips curve, see Appendix C for a detailed derivation. An increase in government spending raises output if $\Lambda > 0$. Then, also both types of employment and hence aggregate employment increase if $\widehat{g}_t > 0$, see Appendix C.

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

$$\widehat{n}_t^p - \widehat{n}_t^b = \frac{2}{\Lambda \cdot \Delta} \cdot (\Delta - 1) \cdot (\phi - 1) \cdot g \cdot \widehat{g}_t. \tag{24}$$

If the fiscal multiplier is positive ($\Lambda > 0$), 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 proportionately with output 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.[15]

4.3 Numerical results

While the results of the previous section help to understand the basic mechanism, we now investigate the effects of government spending expansions in a calibrated version of our model. Rather than matching the exact profiles of the estimated impulse responses from the empirical VAR model,

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

our aim is to investigate whether the calibrated model generates impulse responses that are generally consistent with our empirical evidence.

We parameterize the model targeting the U.S. economy. The parametrization is a combination of using empirical estimates 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 $n^p/n^b = 1.72$, consistent with its sample mean in our CPS data. The wealth elasticity, the Frisch elasticity, investment adjustment costs, and the elasticity of capital utilization are calibrated according to the estimates in Schmitt-Grohé and Uribe (2012). Specifically, we set $\chi = 0.0001$ implying a near-zero wealth elasticity of labor supply. As a robustness check, we also discuss results for two alternative values of the wealth elasticity of labor supply, $\chi = 0.5$ and $\chi = 1$. The parameter η, which is equal to the Frisch elasticity of labor supply if χ approaches zero, is set to 1/2. 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. Hence, in our calibration, the supply of capital services is more elastic than the supply of labor, $\Delta > \eta$, which is an important ingredient of our mechanism as explained before.

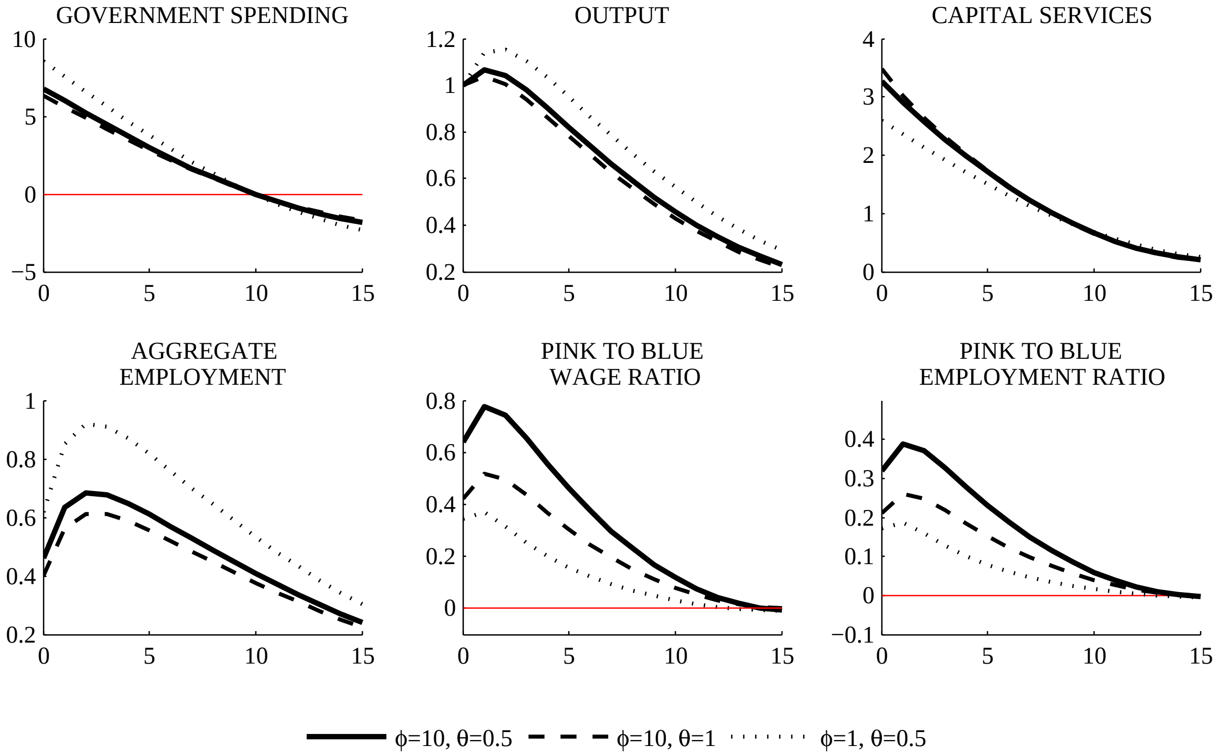
Total factor productivity z is chosen such that steady-state output is normalized to $y = 1$. Steady-state capital is set to $k = 4$ to obtain the standard capital output ratio. The quarterly capital depreciation rate, δ, is calibrated to imply a value for the discount factor equal to $\beta = 0.9927$, consistent with a sample mean of the annualized real interest rate of around 3 percent. This delivers $\delta = 0.022$. The share parameters γ and α are calibrated to generate a steady-state labor income share of 67% and a pink-collar to blue-collar wage ratio in the steady state of 0.86, consistent with its sample mean in our CPS data. This requires $\alpha = 0.49$ and $\gamma = 0.1$. As a benchmark, we set $\phi = 10$ implying that capital services and blue-collar labor are rather close substitutes in production. By contrast, we set $\theta = 1/2$ implying that pink-collar labor and capital services are complements. To demonstrate how ϕ and θ affect our results, we also show impulse responses for the limiting case $\phi = 1$ where blue-collar labor and capital services are a Cobb-Douglas aggregate. In addition, we consider the case $\theta = 1$ where the composite input and pink-collar labor are a Cobb-Douglas aggregate. The price elasticity of demand 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 parameter governing the size of labor adjustment costs, κ_n, is set to 1.85, as estimated by Dib (2003). 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). We impose a zero inflation steady state, that is $\pi = 1$. The steady-state tax rate, steady-state government spending, and the annualized steady-state debt to GDP ratio are set to $\tau = 0.28$, $g/y = 0.18$, and $b/(4y) = 0.63$, which are values calculated by Trabandt and Uhlig (2011). The responsiveness of government transfer to changes in government debt is calibrated to $\gamma_{sb} = 0.1$ so as to insure debt sustainability. The parameter γ_g, which captures the feedback effect of public debt on government spending, is set to 0.05. This implies a reaction of spending to debt that is slightly weaker than in Corsetti, Meier, and Müller (2012), consistent with our evidence of a more delayed spending reversal, i.e., a reduction in spending below trend during the course of adjustment after an exogenous increase in government spending. The autocorrelation of the exogenous processes is set to $\rho_j = 0.9$ for $j = a, g$. To facilitate the comparison to the empirical impulse responses, we normalize the size of the innovations so as to generate an impact change in output by one percent.

Using this calibration, the model generates responses of government spending g_t, output y_t, aggregate employment $n_t^p + n_t^b$, capital services $\widetilde{k}_t$, the pink-collar to blue-collar wage ratio w_t^p/w_t^b and the pink-collar to blue-collar employment ratio n_t^p/n_t^b to a government spending shock as summarized in Figure 6. Impulse responses are expressed in percentage deviations from steady state. We display the impulse responses for three different parameterizations of the elasticities of substitution in production: $\phi = 10$, $\theta = 1/2$ (the baseline calibration, solid lines), $\phi = 10$, $\theta = 1$ (dashed lines), and $\phi = 1$, $\theta = 1/2$ (dotted lines).[16]

The lower right panel of Figure 6 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. This result is in line with both, the empirical evidence presented in Section 3 and

[16] Shock sizes are re-scaled such as to generate a change in output by one percent for each parametrization of ϕ and θ.

Figure 6: 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.

the analytical results of the simplified model version. As discussed before, after fiscal expansions, firms raise their demand for capital services more than proportionately with output due to a shift in relative factor prices in favor of capital use. This relative price movement is due to labor supply being less elastic than the supply of capital services. The increased use of capital services reduces the marginal product of blue-collar labor relative to pink-collar labor. This, in turn, lowers the relative demand for blue-collar labor. As a result, fiscal expansions induce a positive co-movement of the pink-collar to blue-collar employment and wage ratio, in line with our empirical results. The higher the substitutability between capital services and blue-collar labor relative to the substitutability between capital services and pink-collar labor, captured by the gap between ϕ and θ, the more pronounced is the pink-collar job boom.

4.4 Discussion

In this section, we first discuss how our results are affected by the parametrization of the wealth elasticity of labor supply χ. Then, we discuss how our explanation squares with the unconditional moments of employment by occupation that we observe in the data.

Wealth elasticity. After a government spending expansion, the associated wealth effect dampens the response of the pink-collar to blue-collar employment ratio, see Figure A8 in Appendix C.2 which compares our baseline results for $\chi \approx 0$ to the results for two alternative parameterizations, $\chi = 0.5$ and $\chi = 1$. The wealth effect leads to a rightward shift of the labor supply curve which tends to reduce wages. This, in isolation, tends to raise the costs of capital services relative to the costs of labor. This, in turns, tends to lower the relative demand for capital services and with it the demand for its complement, which is pink-collar labor. In sum, the wealth effect on labor supply works against a rise in the pink-collar to blue-collar employment ratio after government spending expansions. Importantly, though, the model generates a pink-collar employment boom even if we consider the limiting case $\chi = 1$, where the wealth effect is strongest.

Unconditional moments. The conditional relative occupational employment dynamics after government spending shocks differ markedly from the unconditional moments. We have shown that government spending expansions induce a rise in the pink-collar to blue-collar employment ratio. Thus, conditional on government spending shocks, pink-collar employment is more volatile than blue-collar employment. Blue-collar employment, though, exhibits a stronger unconditional volatility than pink-collar employment. Note that these patterns are not contradictive. First, also in our model, there are shocks that induce employment dynamics favoring blue-collar occupations. Second, in the data, the unconditional fluctuations are arguably also affected by industry dynamics, which are absent in our model due to their limited importance in explaining patterns of occupational employment after fiscal shocks in the data.

To demonstrate the first point, we consider a favorable labor productivity shock in our model. In fact, this shock 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 diametrically opposite dynamics compared to the government spending shock. Figure A9 in Appendix C.2 shows the responses of output, total employment, and the pink-collar to blue-collar employment ratio to a labor productivity shock. The intuition for the disproportionate rise in blue-collar employment is as follows. As labor becomes more productive, firms substitute toward this production factor. With relatively less capital services used, the marginal productivity of its substitute blue-collar labor increases relative to pink-collar labor. Hence, firms raise their demand for blue-collar labor relative to pink-collar labor. In Appendix C.2, we also show this result analytically in the simplified model version.

Note that this does not necessarily imply that all demand shocks trigger shifts towards service, sales, and office occupations and that the high unconditional volatility of blue-collar employment is only driven by supply shocks. Recall that we consider a representative-industry model in order to understand *occupation*-specific employment dynamics. By construction, we thus abstract from composition effects due to disproportionate changes of employment in cyclical industries that employ a disproportionate share of blue-collar workers (such as construction and manufacturing). Instead, we focus on occupational dynamics within industries that we have found to be empirically important (see Figure 5). Other demand shocks than our identified government spending shock may in fact trigger considerable between-industry dynamics and may thus lead to blue-collar employment booms through those industry effects. This seems plausible for shocks that lead, for instance, to disproportionate changes in the demand for investment goods such as investment-specific technology shocks. Hence, the unconditional moments in the data are potentially also driven by such demand shocks which trigger strong industry effects favoring blue-collar intensive industries. Thus, while we have shown that occupations are key for understanding the occupational employment effects of fiscal policy, industries may arguably be important to fully understand reactions to other shocks and the unconditional employment dynamics.

5 Implications

It is well documented that, in general, blue-collar occupations are most strongly affected by cyclical employment fluctuations (see, e.g., Hoynes, Miller, and Schaller 2012), i.e., blue-collar workers are hit hardest during recessions. At the same time, we have shown that blue-collar workers benefit the least from employment growth induced by fiscal expansions. Thus, our results imply that countercyclical fiscal policy, that stabilizes 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. In 2008 and 2009, blue-collar employment fell by around 15 percent relative to its pre-crisis level, as compared to a 3 percent decline in aggregate employment. 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. 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'. 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. In line with this, note that we find a smaller reaction of the pink-collar to blue-collar employment ratio when we exclude the post-2008 period compared to our baseline sample period which is at least indicative that the ARRA stimulus did have similar effects as those we document.

Our results also have gender implications. Heterogeneous occupational employment dynamics translate into gender-specific employment dynamics due to different gender shares across occupations. The observation of disproportionately strong job losses for men received particular attention in the public debate during the Great Recession and was summarized by the newly-coined term 'man-cession' (Perry 2010). Our results imply that a fiscal stimulus during a man-cession generates employment growth mostly for women because they are over-represented in sales, service, and office occupations.

Another 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. Our results imply that the trend in relative employment possibilities is actually accelerated rather than attenuated by expansionary fiscal policy. Moreover, since labor earnings are the primary source of income for most households, the absence of employment gains in (medium-pay) blue-collar occupations tends to accelerate the trend in the income distribution away from blue-collar workers, thereby contributing to rising income polarization.[17] In fact, the decline in blue-collar employment appears to happen foremost in recessions (see Jaimovich and Siu 2012; Hershbein and Kahn 2016). Our results imply that expansionary fiscal policy in recessions contributes to this observation.

Note that our results apply to the broad body of all government expenditures. This does, however, not imply that all fiscal-policy measures necessarily benefit pink-collar occupations as 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 overweigh the occupational employment dynamics within industries such that, in total, blue-collar workers benefit disproportionately.

In fact, our evidence regarding isolated innovations to government investment and government consumption, discussed in Section 3.1, supports this view. Both types of innovations lead to surges also in the other component of government spending but they affect the composition of government spending in markedly different ways. In response to innovations to government investment, government consumption rises less than proportionately such that the composition of government spending shifts towards investment goods which can broadly be understood as output of blue-collar intensive industries. In line with this view, we indeed find that these innovations induce occupational employment dynamics that are less strongly biased towards pink-collar workers. 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.

The emphasis of our analysis was on explaining occupation-specific employment dynamics. This focus was guided by the evidence pointing towards important differences in occupational employment dynamics within industries. We have empirically ruled out that differences in employment dynamics across occupations simply reflect differences in employment dynamics across industries.

[17] According to our results, employment rises in sales and office occupations which are usually considered as middle-skill along with blue-collar occupations. However, employment rises most persistently in low-skill service occupations and not significantly in blue-collar occupations which play an important role in the public debate about the shrinking middle class. Further, also within the group of middle-skill occupations, workers in sales and office occupations earn less than those in blue-collar occupations. In our sample, the average weekly earnings, measured in 2005 dollars, are 496 and 578 in sales occupations and service occupations, respectively, while these numbers are 616, 661, 610, and 584 for construction, installation, production, and transport occupations, respectively.

In fact, our proposed mechanism implies exactly the opposite pattern: differences in employment dynamics across industries are – at least in part – a relabeling of differences in employment dynamics across occupations. To illustrate this, recall that different industries are characterized by different shares of blue-collar and pink-collar labor in total labor. As a consequence, the average degree of substitutability of capital with labor differs across industries. In industries where the share of pink-collar workers is relatively high, labor in total is a rather poor substitute to capital services. In contrast, in blue-collar intensive industries, labor in total is a rather close substitute to capital services. In the latter types of industries, firms can hence meet increased demand without raising labor input by much while this is not possible for firms in pink-collar intensive industries (for instance, because of the high degree of human interaction that characterizes many services in general). Put differently, our mechanism implies that industries employing many pink-collar workers experience disproportionate employment growth even if output grew in an exactly proportionate way across industries. Thus, at least part of differences in employment dynamics between industries is a consequence of occupation-specific factors. For example, Nekarda and Ramey (2011) document that the effects of government spending on labor input are weaker in industries where unionization rates are high. High unionization rates coincide with high shares of blue-collar workers such that these finding may actually reflect the importance of occupations.[18]

Finally, our analysis also suggest that the aggregate effects of government spending shocks depend on the occupational composition of employment. According to our results, the aggregate employment response to a government spending shock is enforced by the share of employment in pink-collar occupations in total employment because, with a high share of pink-collar occupations, labor in total is a relatively poor substitute to capital services.

6 Conclusion

In this paper, we have documented pronounced occupational differences in the 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

[18] 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).

employment. In contrast, we find no discernible employment changes for blue-collar occupations. Thus, government spending expansions induce a significant shift in the composition of employment away from employment in blue-collar occupations towards employment in pink-collar occupations. We have shown that occupation-specific shifts in labor demand are responsible for the heterogenous employment dynamics after government spending expansions. We have presented a business-cycle model that explains the heterogenous occupational employment dynamics as a consequence of occupational differences in the short-run substitutability between capital services and labor. In our model, fiscal expansions induce a rise in pink-collar employment relative to blue-collar employment, in line with what is found in the data.

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Appendix to 'Fiscal Policy and Occupational Employment Dynamics'

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January 2017

Contents

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Support from German Science Foundation (DFG) through SFB 823 is gratefully acknowledged.

A Data appendix

A.1 Occupational employment data

The CPS is a representative monthly household survey conducted by the U.S. Bureau of Labor Statistics, covering a number of demographic and labor-market related questions. The Merged Outgoing Rotation Group (MORG) is a subset of the full CPS sample (more than 25,000 individuals per month) and can be downloaded from the National Bureau of Economic Research. CEPR has prepared several consistent datasets from the CPS available for download. We use these data and checked that aggregating the monthly CPS micro data to quarterly, seasonally adjusted time series yields virtually identical time series as published by the BLS.

Changes in the way the Census defines industries and occupations affect the comparability of the employment series over time. To construct consistent occupational employment data over time, we follow the procedure outlined in Shim and Yang (2016) and use conversion factors provided by the U.S. Census Bureau. Analogously, we use the Census-provided conversion factors for industries to construct consistent employment series by industries. The major occupation and industry groups follow the 2010 Census classification.

We include individuals aged 16 and over and use the CPS Earnings Weight when collapsing the micro data. The CPS Labor Force Status variable is used to classify individuals as employed. To measure hours worked, we use the CPS information on hours worked last week at all jobs. The earnings variable is taken from the CEPR extracts and is defined as usual weekly earnings for hourly and non-hourly workers, including overtime compensation. Nominal variables are converted to $2015 using the U.S. Consumer Price Index.

Note that the conversion factors have been determined for constructing consistent employment series by occupation or industry, respectively. To construct consistent time series for other labor-market outcomes than employment, we use the original conversion factors but adjust the resulting time series using dummies when detrending the (log) data. The dummies shift the series by a constant factor, analogous to the procedure used by Foote and Ryan (2016), and hence assumes that the constant difference between the employment-specific conversion factor matrices and the respective matrix for other labor-market outcomes affects mostly the level of the resulting series. For linear trends, we determine the cyclical component of $\ln x$ in occupation o as the residual to the regression $\ln \widehat{x}_{o,t} = const_{x,o} + \beta_{x,o} \cdot t + \gamma_{x,o} \cdot 1_{t<2003} + \varepsilon_{x,o,t}$, where $1_{t<2003}$ is an indicator variable for the time before 2003, the year where the classification of major occupations has changed to the current classification. We proceed analogously to construct the time series of employment by occupation *and* industry.

A.2 Aggregate data

Table A.1 summarizes the data sources for the aggregate data and Table A.2 shows how we construct the aggregate variables that enter the VAR.

Table A1: Data sources

Series Title	Series ID	Source
Government Consumption Expenditures	A955RC1Q027SBEA	FRED
Gross Government Investment	A782RC1Q027SBEA	FRED
Gross Domestic Product	GDP	FRED
Gross Domestic Product: Implicit Price Deflator	GDPDEF	FRED
Civilian Noninstitutional Population	CNP16OV	FRED
Effective Federal Funds Rate	FEDFUNDS	FRED
Current Tax Receipts	W054RC1Q027SBEA	FRED
Public Debt as Percent of GDP	GFDEGDQ188S	FRED
Mean Forecast for Real Federal Government Consumption Expenditures and Gross Investment	Mean_RFEDGOV_Level	SPF
Mean Forecast for Real State and Local Government Consumption Expenditures and Gross Investment	Mean_RSLGOV_Level	SPF

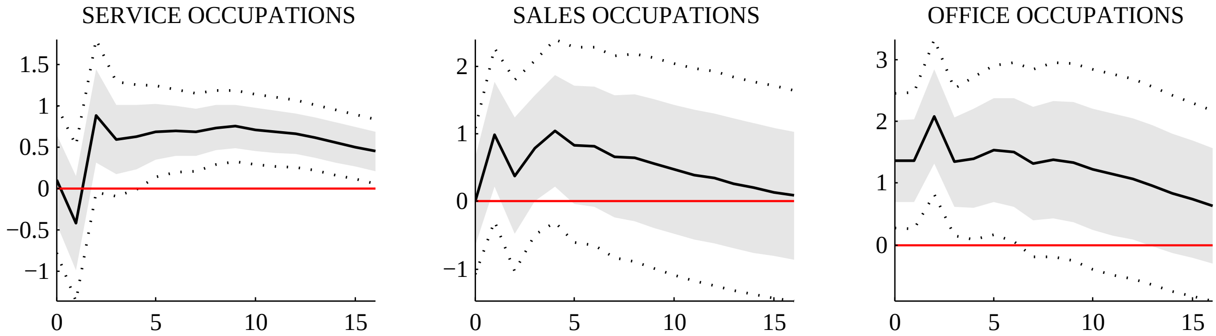
Notes: FRED: Federal Reserve Bank of St. Louis Economic Database, SPF: Survey of Professional Forecasters.

Table A2: Definition of variables

Variable	Definition	Description
Output	$\log \frac{GDP}{GDPDEF \cdot CNP16OV}$	real GDP per capita
Government Spending	$\log \frac{(A955...)+(A782...)}{GDPDEF \cdot CNP16OV}$	real government spending per capita
Government Consumption	$\log \frac{(A955...)}{GDPDEF \cdot CNP16OV}$	real government consumption per capita
Government Investment	$\log \frac{(A782...)}{GDPDEF \cdot CNP16OV}$	real government investment per capita
Tax Receipts	$\log \frac{W054RC1Q027SBEA}{GDPDEF \cdot CNP16OV}$	real government tax receipts per capita
Debt-to-GDP Ratio	$GFDEGDQ188S$	public debt as percent of GDP
Real Interest Rate	$\frac{FEDFUNDS}{100} - \left(\frac{GDPDEF(+1)}{GDPDEF}\right)^4 - 1$	annualized real interest rate
Government Spending Forecast	$\left(\frac{(RFEDGOV+RLSGOV)(+1)}{(RFEDGOV+RLSGOV)}\right)^4 - 1$	forecast made at time t for growth rate of government spending at time $t+1$, annualized

Notes: (+1) indicates a one-quarter lead.

Figure A1: The effects of government spending shocks on employment in service occupations, sales occupations, and office occupations.



Notes: The solid lines are the impulse responses of employment in the major subcategories of pink-collar occupations to a government spending shock. Grey shaded areas and dotted lines show 68 percent and 90 percent confidence bands. The 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.

B Empirical results

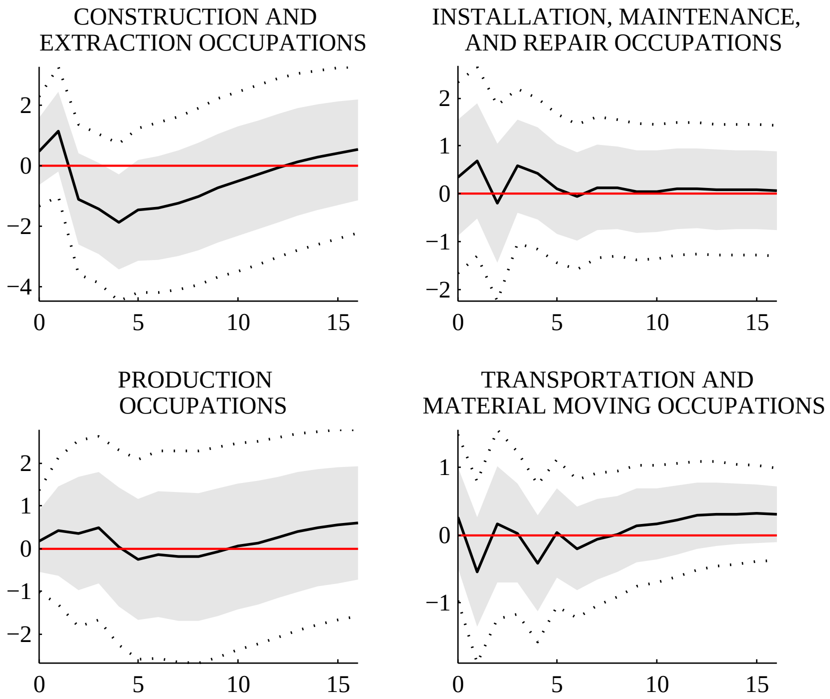
In this appendix, we first present additional results on occupational employment dynamics in response to fiscal policy. Second, we present detailed results of the additional specifications discussed in Section 3 of the main text (alternative VAR specifications, alternative identification of fiscal shocks, and disentangling government investment and government consumption). Third, we discuss employment dynamics in specific sectors and industry groups. Finally, we discuss how we construct a time series of occupational employment which is unrelated to industry dynamics and present estimation results for the constructed series.

B.1 Additional results on occupational employment dynamics

Figure A1 shows the responses of employment in the major subcategories of pink-collar occupations, i.e., service occupations, sales occupations, and office occupations, to the government spending shock. Employment rises in all subcategories of pink-collar occupations. The most significant and most persistent increase is observed for service occupations.

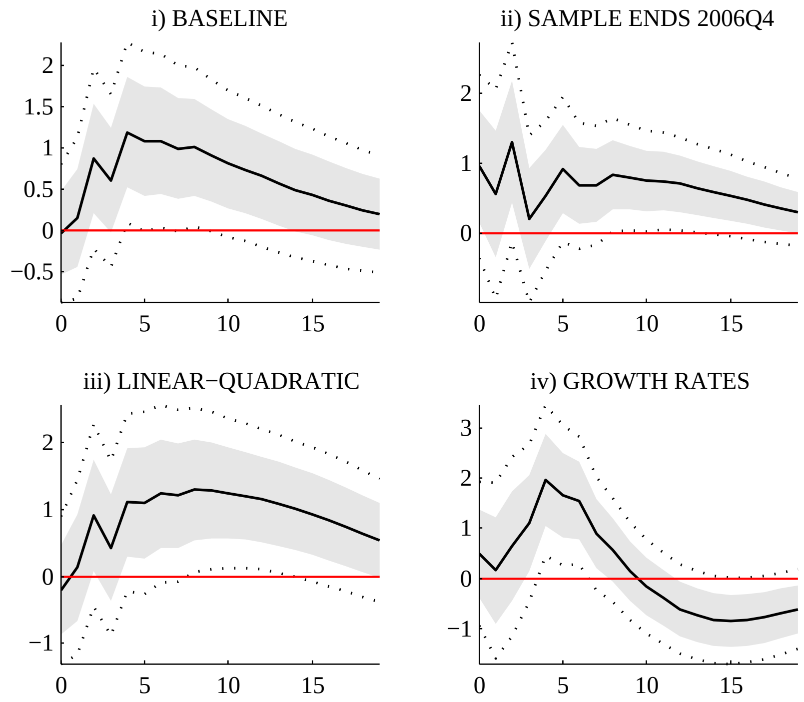
Figure A2 repeats the analysis for the four subcategories of blue-collar occupations. Strikingly, and in sharp contrast to the subcategories of pink-collar occupations, we do not find a significant surge in employment for any blue-collar major occupation.

Figure A2: The effects of government spending shocks on employment in construction and extraction occupations, installation, maintenance, and repair occupations, production occupations, and transportation and material moving occupations.



Notes: The solid lines are the impulse responses of employment in the major subcategories of blue-collar occupations to a government spending shock. Grey shaded areas and dotted lines show 68 percent and 90 percent confidence bands. The 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.

Figure A3: The effects of government spending shocks on pink-collar employment relative to blue-collar employment; alternative detrending methods and alternative sample period.



Notes: The solid lines are the impulse responses of the pink-collar to blue-collar employment ratio to a government spending shock. Grey shaded areas and dotted lines show 68 percent and 90 percent confidence bands. The 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.

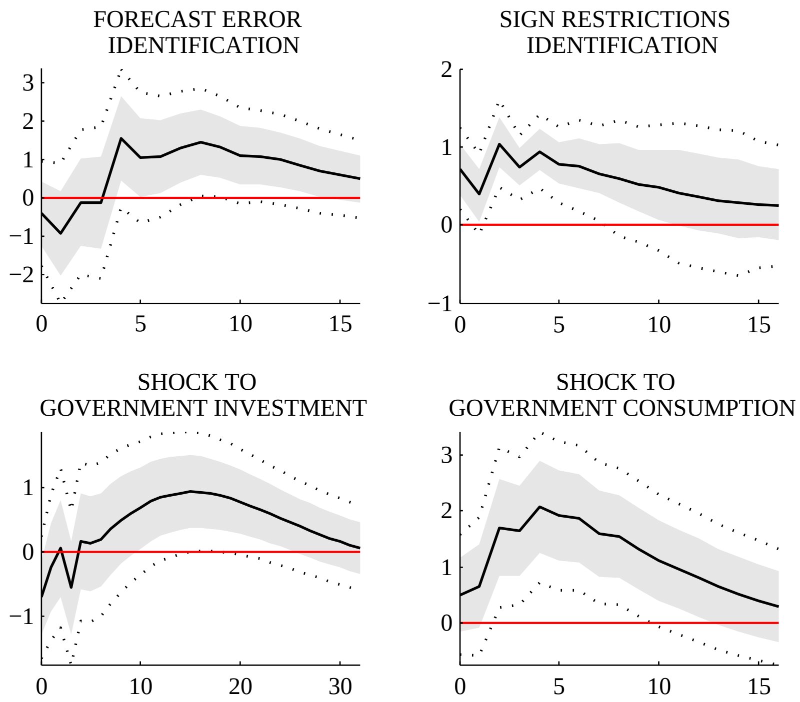
B.2 Alternative VAR specifications

Figure A3 summarizes the results from various robustness checks for our finding that fiscal expansions lead to a disproportionate increase in the employment of pink-collar occupations relative to blue-collar occupations. Panel i) repeats our baseline specification for the sake of comparison. Our main results are robust to excluding the Great Recession and its aftermath from the sample period, see panel ii) where we re-estimated the model on a sample that ends in 2006q4. Our results are also robust to alternative ways of handling trends in the data. Panel iii) shows the response of the pink-collar to blue-collar employment ratio when the data series have been detrended with a linear-quadratic trend, and Panel iv) refers to the case where the variables enter as year-on-year growth rates.

B.3 Alternative identification of fiscal shocks

Figure A4 shows that the blue-collar to pink-collar employment ratio rises, as in our baseline identification, also when we employ two alternative identification schemes for government spending

Figure A4: The effects of government spending shocks on pink-collar employment relative to blue-collar employment; alternative identifications.



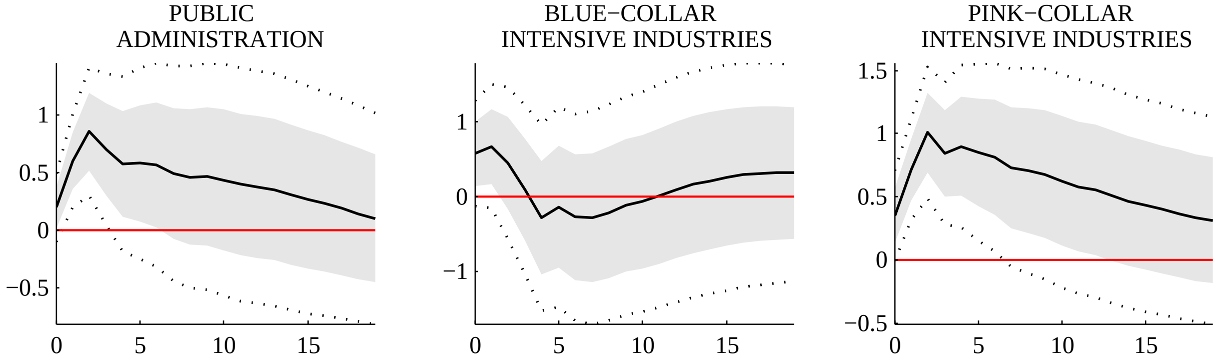
Notes: The solid lines are the impulse responses of the pink-collar to blue-collar employment ratio to a government spending shock (government investment and government consumption in the lower left and lower right panel, respectively). Grey shaded areas and dotted lines show 68 percent and 90 percent confidence bands. The 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.

shocks. The upper left panel shows the response when we measure government spending shocks as innovations to the forecast error of government spending, following Auerbach and Gorodnichenko (2012). To do so, we add the forecast error for the growth rate of government spending, i.e. the difference between the actual, first-release series and the forecasts series, to the set of observables. The forecast error is ordered first and the identification scheme is again recursive.

The upper right panel shows the results from an identification using sign restrictions. In particular, we follow Mountford and Uhlig (2009) and Pappa (2009) and identify fiscal shocks by imposing that a government spending shock raises government spending, GDP and the primary budget deficit, and is orthogonal to a business cycle shock (which we also identify).

The lower left and lower right panels in Figure A4 show results from an exercise where we separately identify exogenous variations in government investment and government consumption. In these VARs, we include the series of government investment and government consumption instead of total government spending. Identification of shocks to government investment (consumption) is

Figure A5: The effects of government spending shocks on employment shares of the public sector and broad industry groups.



Notes: The solid lines are the impulse responses of the share of public employment in total employment (left panel), of the share of employment in blue-collar intensive industries in total employment (middle panel), and of the share of employment in pink-collar intensive industries in total employment (right panel) to a government spending shock. Grey shaded areas and dotted lines show 68 percent and 90 percent confidence bands. The 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.

achieved by ordering the respective variable first in the Cholesky ordering of the VAR. The effects are found to be stronger for variations in government consumption. Most importantly, we find a significant rise in pink-collar relative to blue-collar employment for both components of government spending.[1]

B.4 Between-industry dynamics

Figure A5 displays employment dynamics in specific sectors and industry groups. The left panel shows a surge in public employment after government spending expansions. This surge is only slightly more pronounced than the increase in aggregate employment; the share of public employment in total employment (not shown) rises by only about 0.1 percentage points compared to an average public employment share of about 4.5 percent in our sample. Hence, an expansion of government employment – where pink-collar occupations are over-represented – contributes to the documented occupational employment dynamics but only to a very limited degree.

The middle and right panels of Figure A5 show the employment response in blue-collar intensive and pink-collar intensive industries. We define an industry to be blue-collar intensive if the share of blue-collar workers in this industry is higher than the blue-collar share in aggregate employment.

[1] After an innovation to government investment, the rise in the pink-collar to blue-collar employment ratio is more delayed compared to the case of government consumption (which is why we show the respective response over a longer horizon in the figure)

Pink-collar intensive industries are defined analogously. We observe that employment in pink-collar intensive industries responds more strongly and more persistently to government spending expansions than employment in blue-collar intensive industries. Importantly, though, we observe significantly stronger employment growth for pink-collar occupations also *within* these industry groups, see Figure 5 in the main text.

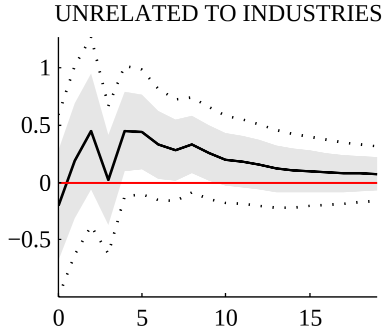
B.5 Occupational employment dynamics unrelated to industry dynamics

In this section, we describe a formal test of the hypothesis that our results are solely reflecting between-industry employment dynamics. We define a hypothetical time series of occupational employment triggered only by industry dynamics: $\hat{o}_t' = S \times i_t'$ where S is the matrix of long-run mean occupation shares in major industries and i_t is the vector of observed employment dynamics in major industries. We then take the difference between the vector of observed occupational employment o_t and the hypothetical occupational employment series: $\varepsilon_t' = o_t' - S \times i_t'$. The residual ε_t is the component of occupational employment dynamics unrelated to industry dynamics. We use all 13 major industries in i_t and a period without re-classifications of occupation- or industry codes in the CPS to determine S. Hence, we can be sure that the results of our test are unaffected by how we group industries or by how we treat re-classifications of industry and occupation variables.

If our documented occupational employment dynamics *were* solely a consequence of industry dynamics, we would not observe any systematic reactions in the occupational employment series which is unrelated to industries, i.e., in ε_t. Figure A6 shows, however, that we do observe a significant shift from blue-collar employment to employment in service, sales, and office occupations also in this component of occupational employment.

From this we conclude that the documented differences in employment dynamics between occupations are due to occupation-specific reasons and not only a consequence of composition effects running from industries to occupations. As a consequence, differences in employment dynamics between industries are then in part a result of occupation-specific reasons through a composition effect running from occupations to industries. Hence, a pure within-industry perspective distills occupational employment dynamics unrelated to industries but understates the importance of occupation-specific factors for economy-wide occupational employment dynamics because it ig-

Figure A6: The effects of government spending shocks on pink-collar employment relative to blue-collar employment unrelated to industry dynamics.



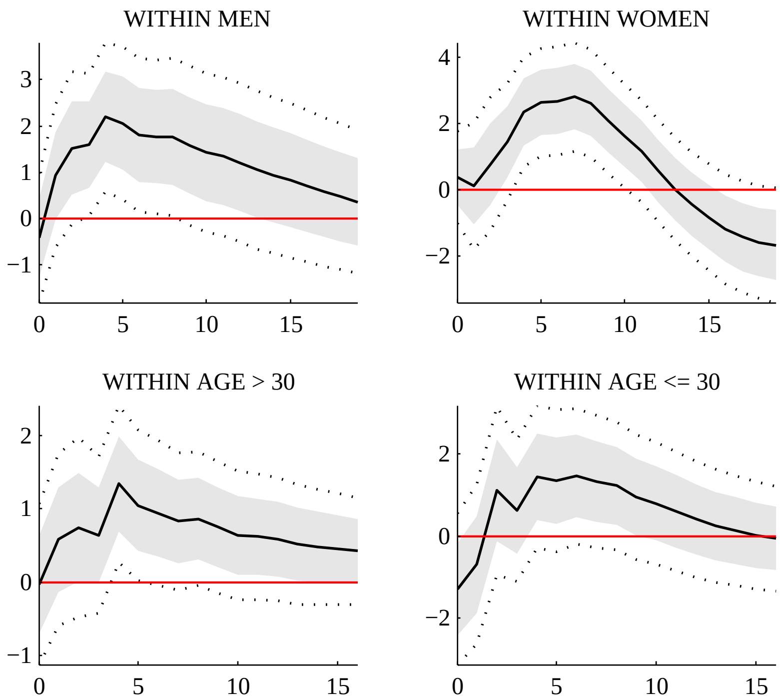
Notes: The solid line is the impulse response of the pink-collar to blue-collar employment ratio unrelated to industry dynamics to a government spending shock. The grey shaded area and the dotted lines show 68 percent and 90 percent confidence bands. The responses are expressed in percentage terms. On the horizontal axes, the horizon is given in quarters. The impact response of output (not shown) is normalized to one percent.

nores also those between-industry dynamics which are due to occupation-specific reasons. Note that our formal test is constructed in a way diametrically opposed to our own hypothesis. The hypothesis that we want to reject is that there are no occupation-specific employment effects. If this were the case, all observed industry dynamics would be truly driven by industry-specific effects. Notice, however, that – according to our evidence displayed in Figure A6 – there are occupation-specific effects. Thus, some of the industry dynamics displayed in Figure A5 are actually reflecting occupation-specific employment effects due to differences in the occupation-mix across industries. To understand this possibility, consider the following thought experiment. Suppose pink-collar employment grows by 1% in every industry while employment in other occupations stays constant. In this experiment, the percentage employment growth in an industry would be equal to the specific industry's share of pink-collar workers. In the theoretical part of paper, we provide an explanation for occupation-specific employment dynamics based on differences in the substitutability between capital services and labor across occupations. Put differently, the responses shown in Figure A6 exclude all within-industry dynamics and thus also those which are actually driven by occupation-specific dynamics and, hence, understate the true importance of occupations.

B.6 Workers' characteristics

Figure A7 shows occupational employment dynamics by gender and age. In the upper left panel, we only consider males and show that, also in this group, pink-collar employment grows more strongly in response to fiscal expansions than blue-collar employment. The upper right panel shows that the same holds in the group of women. The lower panels show that the pink-collar to blue-collar employment ratio also rises in the group of old workers aged 30 and above (left panel) and in the group of young workers aged below 30 (right panel), respectively. These results are important since one may argue that occupational employment dynamics are simply reflecting gender-specific or age-specific employment dynamics due to, first, different gender or shares across occupations and, second, gender or age differences in labor-supply elasticities or attachments to the labor market. If our results were solely driven by, e.g., women raising their labor supply after fiscal expansions, we would also observe a rise in the aggregate pink-collar to blue-collar employment ratio due to a composition effect. We would, however, not observe an increase in the pink-collar to blue-collar employment ratio within the groups of men and women, respectively. Hence, the observation of occupational employment dynamics within gender allows to reject the hypothesis that the aggregate occupational employment dynamics are just a reflection of gender-specific employment dynamics. A similar argument applies to age.

Figure A7: The effects of government spending shocks on pink-collar employment relative to blue-collar employment within gender and within age groups.



Notes: The solid lines are the impulse responses of the pink-collar to blue-collar employment ratio to a government spending shock. Grey shaded areas and dotted lines show 68 percent and 90 percent confidence bands. The 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.

C Model appendix

This model appendix derives, first, the analytical solution of the simplified model discussed in Section 4.2 of the main text. Second, it presents additional model results discussed in Section 4.4.

C.1 Simplified model

Applying the parameter restrictions discussed in the main text, the set of equilibrium conditions simplifies to the following system where a dash attached to the equation number indicates the simplified version of the respective equation in the main text:

$$y_{j,t} = z \cdot \left(\left(\frac{1}{2} \cdot \tilde{k}_{j,t}^{\frac{\phi-1}{\phi}} + \frac{1}{2} \cdot \left(a_t \cdot n_{j,t}^b \right)^{\frac{\phi-1}{\phi}} \right)^{\phi/(\phi-1)} \right)^{1/2} \left(a_t \cdot n_{j,t}^p \right)^{1/2}, \tag{1'}$$

$$\log a_t = \log a + \varepsilon_t^a$$

$$r_t^k = \frac{1}{4} \cdot z \cdot mc_t \cdot \left(\frac{1}{2} \cdot \tilde{k}_t^{\frac{\phi-1}{\phi}} + \frac{1}{2} \cdot \left(a_t n_t^b \right)^{\frac{\phi-1}{\phi}} \right)^{\phi/2(\phi-1)-1} (a_t n_t^p)^{1/2} \, \tilde{k}_t^{-1/\phi}, \tag{3'}$$

$$w_t^b = \frac{z}{4} mc_t a_t \left(\frac{1}{2} \tilde{k}_t^{\frac{\phi-1}{\phi}} + \frac{1}{2} \left(a_t n_t^b \right)^{\frac{\phi-1}{\phi}} \right)^{\phi/2(\phi-1)-1} \cdot (a_t n_t^p)^{1/2} \cdot \left(a_t n_t^b \right)^{-1/\phi}, \tag{4'}$$

$$w_t^p = \frac{1}{2} \cdot mc_t \cdot (y_t / n_t^p), \tag{5'}$$

$$\psi(\pi_t - 1)\pi_t = \psi \beta \, \mathrm{E}_t \left\{ \frac{\lambda_{t+1}}{\lambda_t} \frac{y_{t+1}}{y_t} (\pi_{t+1} - 1)\pi_{t+1} \right\} + \epsilon \left(mc_t - \frac{\epsilon - 1}{\epsilon} \right), \tag{6'}$$

$$\lambda_t = \left(c_t - \left(\frac{\Omega^p}{2} (n_t^p)^2 + \frac{\Omega^b}{2} (n_t^b)^2 \right) \right)^{-1}, \tag{12'}$$

$$\lambda_t = \beta \, \mathrm{E}_t \left\{ \lambda_{t+1} \frac{(1 + r_t)}{\pi_{t+1}} \right\}, \tag{14'}$$

$$(1 - \tau) r_t^k = \delta_1 + \delta_2 (u_t - 1), \tag{17'}$$

$$(1 - \tau) w_t^b = \Omega^b n_t^b, \tag{18'}$$

$$(1 - \tau) w_t^p = \Omega^p n_t^p, \tag{19'}$$

$$\log \left(\frac{1 + r_t}{1 + r} \right) = \delta_\pi \log (\pi_t / \pi) \tag{20'}$$

$$\log g_t = \log g + \varepsilon_t^g$$

$$y_t = c_t + g_t + e_t(u_t) k_t, \tag{22'}$$

which uses that $\chi = 0$ implies $x_t = x_{t-1} = x$ which we normalize to one and that $\kappa_i \to \infty$ together with $\delta = 0$ imply that the stock of physical capital is constant, i.e. $k_t = k_{t-1} = k$, and hence $\widetilde{k}_t = k \cdot u_t$.

In log-linear terms, we obtain the following system where a double dash attached to the equation number indicates the log-linearization of the respective simplified equilibrium condition:

$$\widehat{y}_t = \frac{1}{4} \cdot \left(\widehat{u}_t + \widehat{a}_t + \widehat{n}_t^b\right) + \frac{1}{2} \cdot (\widehat{a}_t + \widehat{n}_t^p)\,, \tag{1”}$$

$$\widehat{a}_t = \varepsilon_t^a$$

$$\widehat{r}_t^k = \widehat{mc}_t - \frac{2+\phi}{4\phi}\widehat{u}_t + \frac{2+\phi}{4\phi} \cdot \widehat{a}_t + \frac{2-\phi}{4\phi} \cdot \widehat{n}_t^b + \frac{1}{2} \cdot \widehat{n}_t^p\,, \tag{3”}$$

$$\widehat{w}_t^b = \widehat{mc}_t + \frac{2-\phi}{4\phi} \cdot \widehat{u}_t + \frac{5\phi-2}{4\phi} \cdot \widehat{a}_t - \frac{2+\phi}{4\phi}\widehat{n}_t^b + \frac{1}{2} \cdot \widehat{n}_t^p, \tag{4”}$$

$$\widehat{w}_t^p = \widehat{mc} + \frac{1}{4} \cdot \left(\widehat{u}_t + \widehat{a}_t + \widehat{n}_t^b\right) + \frac{1}{2} \cdot \widehat{a}_t - \frac{1}{2}\widehat{n}_t^p, \tag{5”}$$

$$\widehat{\pi}_t = \beta\, \mathrm{E}_t\, \widehat{\pi}_{t+1} + \kappa \cdot \widehat{mc}_t\,, \tag{6”}$$

$$\lambda^2 \cdot \widehat{\lambda}_t = -\widehat{c}_t + \Omega^p \cdot \widehat{n}_t^p + \Omega^b \cdot \widehat{n}_t^b\,, \tag{12”}$$

$$\widehat{\lambda}_t = \mathrm{E}_t\, \widehat{\lambda}_{t+1} + \widehat{R}_t - \mathrm{E}_t\, \widehat{\pi}_{t+1}\,, \tag{14”}$$

$$\widehat{r}_t^k = \Delta^{-1} \cdot \widehat{u}_t\,, \tag{17”}$$

$$\widehat{w}_t^b = \widehat{n}_t^b\,, \tag{18”}$$

$$\widehat{w}_t^p = \widehat{n}_t^p\,, \tag{19”}$$

$$\widehat{R}_t = \delta_\pi \widehat{\pi}_t \tag{20”}$$

$$\widehat{g}_t = \varepsilon_t^g,$$

$$\widehat{y}_t = \frac{c}{y}\widehat{c}_t + \frac{g}{y}\widehat{g}_t + \frac{\delta_1}{y}\widehat{u}_t, \tag{22”}$$

where $\kappa = (\epsilon - 1)/\psi$ is the slope of the linearized Phillips curve, and $R_t = 1 + r_t$.

We combine conditions (3”), (4”), (5”), (17”), (18”), and (19”) and obtain the following factor market clearing conditions:

$$\left(\Delta^{-1} + \frac{2+\phi}{4\phi}\right) \cdot \widehat{u}_t = \widehat{mc}_t + \frac{2+\phi}{4\phi} \cdot \widehat{a}_t + \frac{2-\phi}{4\phi} \cdot \widehat{n}_t^b + \frac{1}{2} \cdot \widehat{n}_t^p, \tag{1}$$

$$\frac{2+5\phi}{4\phi} \cdot \widehat{n}_t^b = \widehat{mc}_t + \frac{2-\phi}{4\phi} \cdot \widehat{u}_t + \frac{5\phi-2}{4\phi} \cdot \widehat{a}_t + \frac{1}{2} \cdot \widehat{n}_t^p, \tag{2}$$

$$\frac{3}{2} \cdot \widehat{n}_t^p = \widehat{mc}_t + \frac{1}{4} \cdot \left(\widehat{u}_t + \widehat{a}_t + \widehat{n}_t^b\right) + \frac{1}{2} \cdot \widehat{a}_t. \tag{3}$$

Further, the absence of serial correlations in the disturbances and endogenous state variables implies

$\mathrm{E}_t\,\widehat{\pi}_{t+1} = \mathrm{E}_t\,\widehat{\lambda}_{t+1} = 0$ which allows to combine conditions (6"), (12") (14"), (20"), and (22") to

$$\frac{y}{c}\cdot\widehat{y}_t - \frac{g}{c}\cdot\widehat{g}_t - \frac{\delta_1}{c}\cdot\widehat{u}_t = \Omega^p\cdot\widehat{n}_t^p + \Omega^b\cdot\widehat{n}_t^b - \Gamma\cdot\widehat{mc}_t, \tag{4}$$

where $\Gamma = \delta_\pi\cdot\kappa\cdot\lambda^2 > 0$.

Together with the linearized production function (1"), (1)-(3) and (4) form a system in five equations and five endogenous variables each period. In this system, $\widehat{u}_t$, $\widehat{n}_t^b$, $\widehat{n}_t^p$, $\widehat{y}_t$, and $\widehat{mc}_t$ are endogenous while $\widehat{g}_t = \varepsilon_t^g$ and $\widehat{a}_t = \varepsilon_t^a$ are determined exogenously. Since there is no persistence, the system of linear equations is static in each period and can be solved for the following equations for output and both types of labor:

$$\widehat{y}_t = \Lambda^{-1}\left(\Delta^{-1} + 3\phi + 5\Delta^{-1}\phi + 7\right) g\cdot\widehat{g}_t + \xi_{y,a}\cdot\widehat{a}, \tag{5}$$

$$\widehat{n}_t^b = \Lambda^{-1}\left(8\Delta^{-1}\phi + 8\right) g\cdot\widehat{g}_t + \xi_{n,a}\cdot\widehat{a}_t, \tag{6}$$

$$\widehat{n}_t^p = \Lambda^{-1}\left(2\Delta^{-1} + 2\phi + 6\Delta^{-1}\phi + 6\right) g\cdot\widehat{g}_t + \xi_{p,a}\cdot\widehat{a}_t, \tag{7}$$

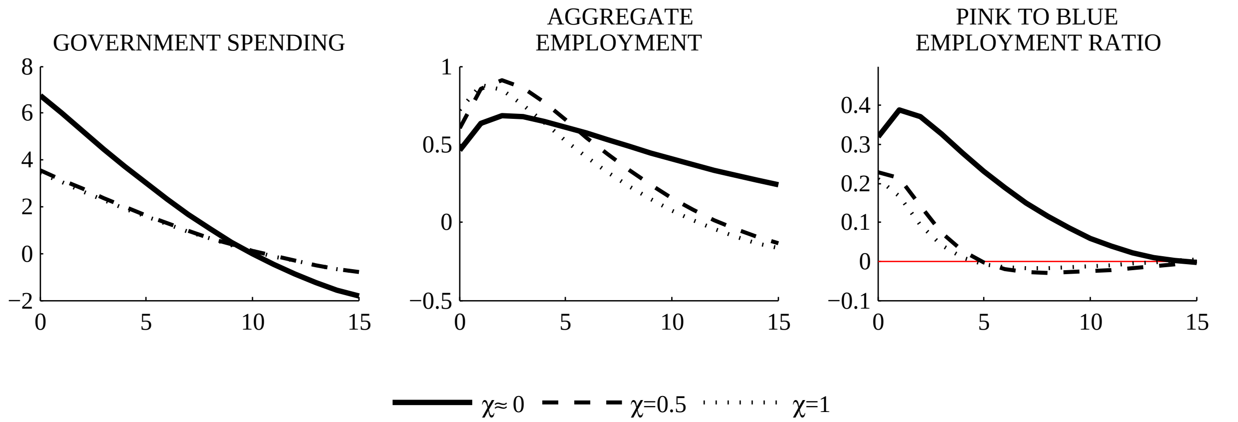
where Λ is defined as in the main text and $\xi_{y,a} = \Lambda^{-1}\cdot(2\cdot\Gamma\cdot c\cdot(5+\Delta^{-1}+\phi+2\Delta^{-1}\phi)+\frac{1}{2}\cdot(6\Omega^b\phi+\Omega^b\phi^{-1}+\Delta^{-1}\Omega^p)\cdot c-2\delta_1(1+5\phi)-\frac{1}{4}((36+20\Delta^{-1}\phi+4\Delta^{-1}+2\phi^{-1})\Omega^b+(20+11\Delta^{-1}+4\phi+15\Delta^{-1}\phi)\Omega^p)\cdot c)$, $\xi_{n,a} = \Lambda^{-1}\cdot(\Gamma\cdot c\cdot(5+\phi+9\Delta^{-1}\phi-3\Delta^{-1})+8\delta_1+3\phi+2c\Omega^p+2c\Delta^{-1}\Omega^p-9-8\phi\delta_1-\Delta^{-1}-5\Delta^{-1}\phi-2c\Omega^p\phi-2c\Delta^{-1}\Omega^p\phi)$, and $\xi_{p,a} = \Lambda^{-1}\cdot(\Gamma\cdot c\cdot(\Delta^{-1}+5+\phi+5\Delta^{-1}\phi)+4\delta_1+2c\Omega^b\phi+2c\Delta^{-1}\Omega^b\phi-5-\phi-4\phi\delta_1-\Delta^{-1}-2c\Omega^b-2c\Delta^{-1}\Omega^b-5\Delta^{-1}\phi)$. Setting $\widehat{a}_t = 0$ yields equation (23) in the main text and subtracting (6) from (7) gives equation (24) in the main text.

C.2 Additional model results

We present two additional model results. First, we demonstrate that, qualitatively, our results do not hinge on how we parameterize the wealth effect on labor supply. Second, we show that labor productivity shocks lead to a *decline* in the pink-collar to blue-collar employment ratio.

Wealth elasticity. Figure A8 displays results for alternative values of the wealth elasticity of labor supply. As discussed in Section 4.4, a stronger wealth effect on labor supply (i.e., an increase in the parameter χ) dampens the impact of a spending shock on the employment ratio, see Figure A8. Notice, however, that the employment ratio rises even in the limiting case $\chi = 1$.

Figure A8: Model-implied impulse responses to a government spending shock for different wealth elasticities.



Notes: The responses are expressed in percentage terms. On the horizontal axes, the horizon is given in quarters. The size of the innovation is normalized such that the response of output (not shown) is one percent on impact.

Labor productivity shocks. In the simplified model version, the effects of an innovation to labor productivity, a_t, are not unambiguous but depend on the slope of the Phillips curve as measured by the composite parameter κ. If the Phillips curve is not too flat, i.e., κ not too small, a positive labor productivity shock raises output and aggregate employment but lowers the pink-collar to blue-collar employment ratio provided that blue-collar labor is a closer substitute to capital services than pink-collar labor. To demonstrate this, consider the limiting cases $\epsilon \to \infty$ (perfect competition) or $\psi \to 0$ (no price adjustment costs) which both lead to $\kappa \to \infty$.

In the limiting case where $\kappa \to \infty$, condition (6") implies $\widehat{mc}_t = 0$ such that conditions (1") and (1)-(3) form a system in four equations and four endogenous variables, $\widehat{u}_t$, $\widehat{n}_t^b$, $\widehat{n}_t^p$, and $\widehat{y}_t$ while $\widehat{mc}_t = 0$ and $\widehat{a}_t = \varepsilon_t^a$ is determined exogenously. Solving the static system of linear equations in each period yields

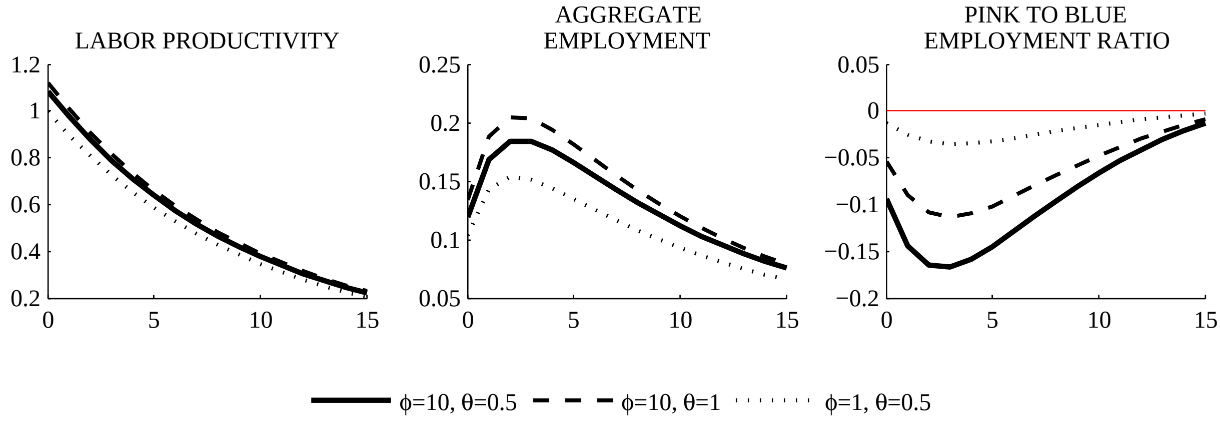
$$\widehat{y}_t = \frac{2\Delta^{-1} + 2\phi + 10\Delta^{-1}\phi + 10}{3\Delta^{-1} + \phi + 7\Delta^{-1}\phi + 5} \cdot \widehat{a}_t, \tag{8}$$

and

$$\widehat{n}_t^b = \frac{\phi + 9\Delta^{-1}\phi - 3\Delta^{-1} + 5}{3\Delta^{-1} + \phi + 7\Delta^{-1}\phi + 5} \cdot \widehat{a}_t, \tag{9}$$

$$\widehat{n}_t^p = \frac{\Delta^{-1} + \phi + 5\Delta^{-1}\phi + 5}{3\Delta^{-1} + \phi + 7\Delta^{-1}\phi + 5} \cdot \widehat{a}_t. \tag{10}$$

Figure A9: Model-implied impulse responses to labor productivity shock.



Notes: The responses are expressed in percentage terms. On the horizontal axes, the horizon is given in quarters. The size of the innovation is normalized such that the response of output (not shown) is one percent on impact.

Subtracting (9) from (10) gives

$$\widehat{n}_t^{\,p} - \widehat{n}_t^{\,b} = \frac{4}{3 + \Delta\phi + 7\phi + 5\Delta} \cdot (1 - \phi) \cdot \widehat{a}_t. \tag{11}$$

Output rises unambiguously in $\widehat{a}$. If blue-collar labor is a closer substitute to capital services than pink-collar labor ($\phi > 1$), the pink-collar to blue-collar employment ratio falls in response to a positive labor productivity shock ($\widehat{a} > 0, \widehat{g} = 0$). The intuition is as follows. As labor becomes more productive, firms substitute toward this production factor. With relatively less capital services used, the marginal productivity of the substitute blue-collar labor increases relative to pink-collar labor. Hence, firms raise their demand for blue-collar labor relative to pink-collar labor.

Similar relations also hold for less restrictive assumptions concerning the slope of the Phillips curve. By continuity, there exists a $\kappa^* < \infty$ such that the following results hold: If blue-collar labor is a closer substitute to capital services than pink-collar labor ($\phi > 1$) and the Phillips curve is sufficiently steep ($\kappa > \kappa^*$), a positive labor productivity shock also raises output and aggregate employment but reduces the pink-collar to blue-collar employment ratio.

Figure A9 shows impulse responses to an innovation in labor productivity obtained using the calibrated full model. As for fiscal shocks, we show results for three different parameterizations of the elasticities of substitution in production. In response to an increase in labor productivity a_t, firms substitute away from capital services into labor. Employment in blue-collar occupations, which is a closer substitute to capital services than pink-collar labor, rises disproportionately. The larger is the difference between ϕ and θ, the stronger is the gap in the degree of substitutability with capital services across occupations and, thus, the stronger is the increase in blue-collar employment.

To sum up, a favorable labor productivity shocks leads to stronger employment growth for blue-collar workers relative to pink-collar workers and thus leads to diametrically opposite occupational employment dynamics compared to government spending expansions.