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MAN-CESSIONS, FISCAL POLICY, AND THE GENDER COMPOSITION OF EMPLOYMENT

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Man-cessions, Fiscal Policy, and the Gender Composition of Employment*

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Abstract

In recessions, predominantly men lose their jobs, which has been described by the term "man-cessions". We analyze whether fiscal expansions bring men back into jobs. We show empirically that expansionary fiscal shocks predominantly raise the employment of women, which further destabilizes the gender composition of employment in recessions. Our results show that man-cessions are triggered by industry effects while the gender-specific employment effects of fiscal policy are driven by disproportionate employment changes in female-dominated occupations, specifically so-called "pink-collar" occupations. We develop a business-cycle model that explains these occupational employment dynamics as a consequence of differences in the substitutability between capital and labor across occupations.

Keywords: Fiscal Policy, Gender, Employment, Occupations

JEL classification: J16, E62, E32, J21

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1 Introduction

In economic downturns, predominantly men are laid off. This observation received particular attention in the public debate during the Great Recession when the term "man-cession" was coined.[1] Between 2007Q3 and 2009Q1, more than three out of four (78%) of the jobs lost in the U.S. were held by men. In relative terms, male employment fell by 4.8% while female employment fell by only 1.4%. Notably, the observation of man-cessions is neither restricted to the Great Recession nor to the U.S. economy. For instance, Wall (2009) and Hoynes, Miller, and Schaller (2012) have documented similar observations during every recession since 1968. Contessi and Li (2014) have found evidence for stronger surges in male unemployment in each of the G7 countries and the OECD as a whole during the 2007-2009 downturn.

Against this background, fiscal policy deserves particular attention. Expansionary fiscal policy not only intends to stabilize the total level of employment, but stabilizing the distribution of employment is often an additional, major goal of fiscal policy in times of crisis. For example, point 2 in the statement of purpose of the ARRA stimulus of 2008 stated that it was the bill's goal "to assist those most impacted by the recession". According to the evidence above, those most impacted by the recession were predominantly men. In fact, some commentators criticized the ARRA stimulus for the supposed gender composition of the created jobs.[2]

In this paper, we provide empirical evidence on the dynamic effects of fiscal policy on the distribution of employment by gender and present a theoretical explanation for our findings in the framework of a business-cycle model. In the first part of the paper, we estimate vector-autoregressive (VAR) models and identify fiscal and non-fiscal (business-cycle) shocks using sign restrictions. We consider sign restrictions as the most suitable identification procedure for our purposes because this method allows us to easily discriminate between fiscal policy on the one hand and all other drivers of the business cycle on the other hand. Specifically, our econometric treatment informs us whether non-fiscal shocks are associated with man-cessions in the first place, at the same time being informative about whether fiscal shocks have a different effect than non-fiscal shocks on the gender composition of employment.

[1] Economist Mark Perry, who coined the term, testified on the issue of man-cessions before the Means and Ways committee of the U.S. congress on June 17, 2010.

[2] Interestingly, both directions of gender inequity have been discussed, see, for instance, the contributions by Christina Hoff Sommers in the Weekly Standard (Jun. 29, 2009) and by Bryce Covert in the Huffington Post (Sep. 24, 2010).

Our results confirm that man-cessions are an important and robust feature of the business cycle. We show that non-fiscal shocks generate a negative co-movement between the relative employment of women and aggregate measures of the business cycle such as GDP or employment. This means that male employment is more responsive to cyclical changes than female employment, which is in line with previous evidence on man-cessions, reviewed below.

Most interestingly, we document that the reverse holds for fiscal policy shocks. Fiscal shocks lead to a positive co-movement between aggregate measures of the business cycle and the relative employment of women. This means that, in response to fiscal expansions, the employment of women rises significantly more strongly than the employment of men.

Taken together, these findings have striking policy implications. Men are hit hardest in recessions but a fiscal stimulus predominantly fosters job creation for women. Thus, fiscal policy faces a trade-off: In recessions, a fiscal stimulus cushions the drop in aggregate employment, but more women than men are brought into jobs. In turn, this amplifies the fluctuation in the gender composition of employment.

In the second part of the paper, we investigate empirically which factors explain man-cessions and the female-biased employment effects of fiscal policy, respectively. Our results indicate that man-cessions are foremost the consequence of industry effects. Adverse non-fiscal shocks lead to disproportionate employment reductions in industries which are characterized by a disproportionate share of male workers. This lends support to the view on man-cessions discussed in the literature (e.g., Hoynes, Miller, and Schaller 2012).

By contrast, we find that the female-biased employment effects of fiscal policy can not be explained by industry effects. Rather, we document that occupational dynamics play an important role for the effects of fiscal policy. Expansionary fiscal shocks cause employment in female-dominated occupations to rise disproportionately. Specifically, we find that services, clerical and retail sales occupations, so-called "pink-collar" occupations, grow disproportionately in response to fiscal shocks. By contrast, blue-collar occupations such as production, craft, transport and construction occupations, which are mostly held by men, grow substantially less in response to fiscal shocks. Thus, expansionary fiscal policy shocks lead to so-called "pink-collar job booms" which, in turn, lead to an increase in the aggregate share of female employment via a composition effect. We

conclude from our analysis that pink-collar job booms are key for understanding the female-biased employment effects of fiscal policy.

In the third part of the paper, we develop a business-cycle model that explains the pink-collar job booms triggered by fiscal expansions. The main non-standard element in this model is a production technology in which the substitutability between capital services and labor differs across occupations. Such a production technology resembles the one used by Autor and Dorn (2013) who explain long-run job polarization in the U.S. In our business-cycle context, we model blue-collar labor as a closer substitute to capital services than pink-collar labor in the short-run. This is motivated by the fact that, in many blue-collar occupations, demand peaks can not only be served by hiring more workers but also by using machines more intensely. By contrast, many pink-collar occupations involve a substantial share of direct human interaction that is difficult to provide by machines. Together with a relatively inelastic supply of labor compared to capital services (e.g., machine hours), this production function leads to the result that expansionary fiscal shocks induce pink-collar job booms: 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 product of blue-collar labor relative to pink-collar labor because blue-collar labor is the closer substitute to capital services. Hence, firms raise their demand for pink-collar labor relative to their demand for blue-collar labor. Together with an overall rise in employment, this generates a pink-collar job boom.

Our paper is related to the literature investigating gender differences in employment cyclicalities, see, e.g., Clark and Summers (1981), Elsby, Hobijn, and Şahin (2010), or Hoynes, Miller, and Schaller (2012).[3] This literature has shown that men bear a disproportionately high share of cyclical employment variation. Our results with respect to the effects of non-fiscal shocks corroborate this finding. Our main contribution to this literature is to provide evidence on the effects of fiscal expansions on the gender composition of employment. Giavazzi and McMahon (2012) have investigated the effects of a specific fiscal shock, increases in military spending, on different population groups. Their finding that military spending increases hours worked disproportionately in households with female heads is broadly consistent with our results.

[3] Jefferson (2005), Jefferson (2008), and Rodgers (2008) have studied employment fluctuations for other population groups than genders.

The remainder of this paper is organized as follows. In Section 2, we present our baseline estimations for the empirical effects of non-fiscal and fiscal shocks on the gender composition of employment. Thereafter, in Section 3, we investigate empirical drivers of the gender-specific employment effects that we document. This analysis provides guidance for the theoretical model that is developed in Section 4. Section 5 concludes.

2 Empirical analysis

In this section, we first present our econometric approach for estimating the effects of fiscal and non-fiscal shocks on the gender composition of employment. Second, we discuss the results of our baseline specification. We then briefly discuss a series of robustness checks for our baseline results.

2.1 Econometric specification

We estimate vector-autoregressive models and use sign restrictions to identify the effects of fiscal policy shocks and non-fiscal shocks on the gender composition of employment. Our baseline VAR includes constants and three lags of quarterly U.S. data on the primary fiscal deficit, real GDP, aggregate employment, and the employment ratio between women and men.[4] Our main interest is on the reaction of the gender employment ratio to different shocks. A significant reaction of the gender employment ratio is tantamount to a significantly different response of male and female employment to the respective shock. All variables are measured as percentage deviations from HP trends. Our baseline sample starts in 1964Q1 and ends in 2013Q4. The reduced form VAR reads

$$Y_t = c + \sum_{i=1}^{3} A_i Y_{t-i} + v_t \,,$$

where the vector Y_t includes the variables described above and c is a vector of constants, $A = [A_1, A_2, A_3]$ is the coefficient matrix, and v_t is the vector of reduced-form residuals. The reduced-form VAR is estimated with Bayesian techniques using a Minnesota prior.[5]

We identify a fiscal and a non-fiscal shock using sign restrictions. We impose, following Pappa (2009), that an expansionary fiscal policy shock (which can be a spending increase or a tax cut or

[4] See Appendix A for details on data sources and data construction.

[5] Specifically, for the variance-covariance matrix of the reduced-form shocks Σ, we use the estimate $\widehat{\Sigma}$ from an OLS estimation of the VAR. The prior means for all entries in c and A are zero. For constants, we set the prior variance of the coefficients to 100 and to $0.5 \cdot \frac{\sigma_{jj}}{L^2 \cdot \sigma_{ii}}$ for the impact of the L'th lag of variable j on variable i, where σ_{ii} and σ_{jj} are diagonal entries from the estimate of the variance-covariance matrix of the reduced-form shocks.

a combination of both) raises the primary deficit and output.[6] By contrast, non-fiscal (business-cycle) shocks affect the deficit and output in opposite directions. These identifying restrictions can be derived from mild assumptions: First, expansionary fiscal policy raises output and, second, the endogenous component of fiscal policy is not too procyclical (i.e., in non-fiscally induced booms, government spending does not rise endogenously by more than tax revenues). In order to study fiscal stimuli that bring people into jobs, we impose a further sign restriction on the employment response to fiscal shocks. We impose the sign restrictions on impact and in the following three quarters.[7]

Formally, our identification proceeds as outlined in Uhlig (2005). We take a draw $\widetilde{A}$ from the posterior distribution of the coefficient matrix A and calculate the Cholesky decomposition of the estimated covariance matrix $\widehat{\Sigma} = BB'$. We then take a draw ω from the four-dimensional unit sphere by applying a QR decomposition of a 4×4 matrix of random numbers drawn from the standard normal distribution. We consider shocks $b = B\omega$ and the impulse response functions to b. If they satisfy the sign restrictions, we keep the draw $(\widetilde{A}, \omega)$ and save the impulse response functions. This procedure is repeated until 10,000 responses to both fiscal and non-fiscal shocks are found. For each shock, we order the responses of the 10,000 accepted models to obtain a posterior distribution at each horizon.

2.2 Baseline results

Figure 1 summarizes the estimated responses of the variables in our baseline VAR. We display the median together with the 16th-84th percentiles of the distribution of responses in the accepted models. These probability bands reflect Bayesian parameter uncertainty and identification uncertainty. The horizontal axes show quarters after the shock and the responses are expressed in percentage terms. In both cases, shock are normalized such that GDP changes by 1% on impact.

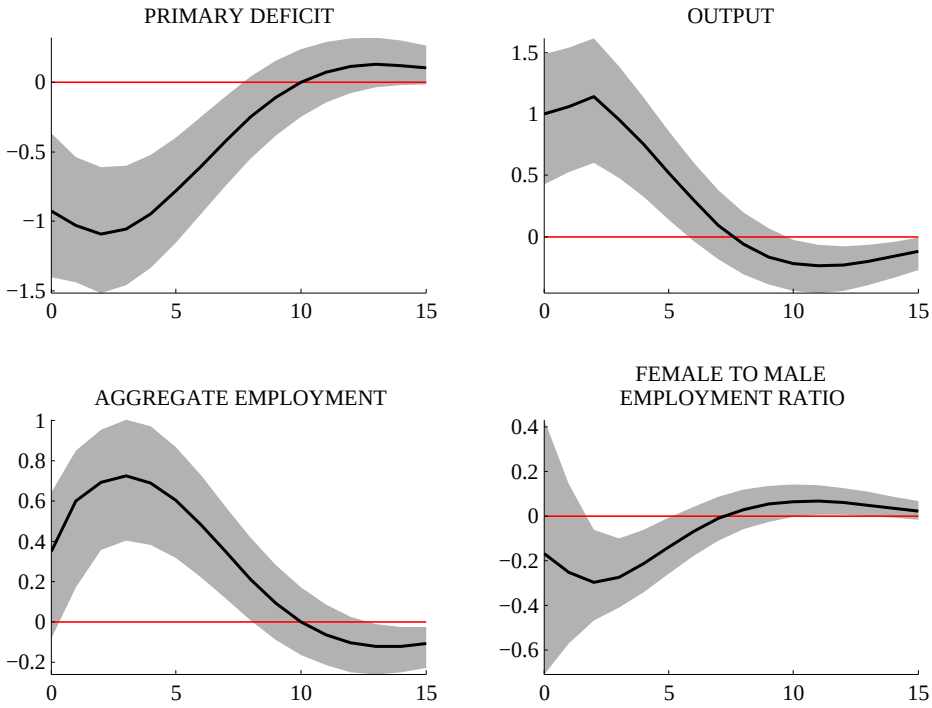
The reactions of the deficit, output, and – in case of the fiscal shock – aggregate employment follow the sign restrictions. After a favorable non-fiscal shock, we also observe a rise in aggregate employment.

Our main interest is on the reaction of the gender employment ratio, displayed in the lower

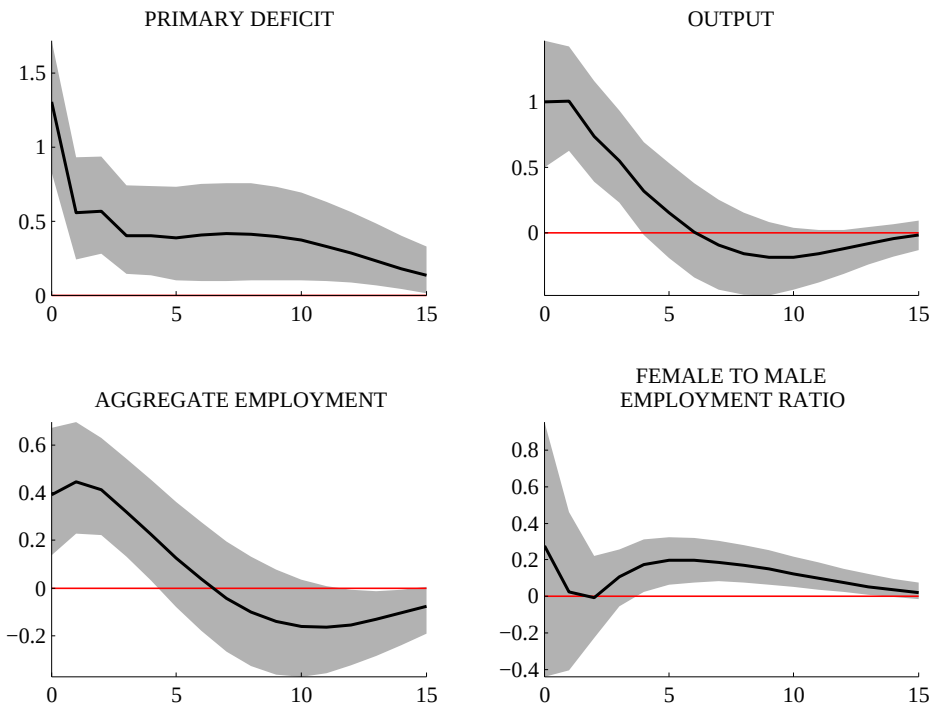
[6] A similar identification of fiscal shocks has been used by, e.g., Enders, Müller, and Scholl (2011).
[7] Our main results are robust to variations of our baseline specification, see Section 2.3.

Figure 1: Impulse responses in baseline VAR.

(a) Non-fiscal shock



(b) Fiscal shock



Notes: The solid lines are the median responses and the grey shaded areas show the 16th-84th percentiles of 10,000 estimated responses. The responses are expressed in percentage terms (for the defict, in terms of output). On the horizontal axes, the horizon is given in quarters. The median impact response of GDP is normalized to one percent.

right panels of Figures 1(a) and 1(b), respectively. After a favorable non-fiscal shock, the female to male employment ratio falls significantly.[8] As aggregate employment rises, this means that male employment rises more strongly than female employment. In the case of a contractionary non-fiscal shock, this means that aggregate employment falls and predominantly male jobs are lost. Thus, in our estimated model, contractionary non-fiscal shocks induce man-cessions.

Strikingly, and contrary to the non-fiscal shock, we observe a pro-cyclical response of the female to male employment ratio conditional on fiscal shocks, see the bottom-right panel in Figure 1(b). After a favorable fiscal shock, there is a significant and delayed rise in the female to male employment ratio.[9] As aggregate employment rises, see the bottom-left panel of Figure 1(b), one can conclude that female employment rises more strongly than male employment in response to expansionary fiscal shocks. Thus, a fiscal stimulus brings predominantly women into jobs.

To demonstrate the quantitative importance of this result, we provide some back-of-the-envelope calculations for the absolute employment change implied by the median responses.[10] One year after a contractionary non-fiscal shock which leads to a decline in GDP by one percent, about 770,000 jobs have been lost, about 495,000 of which were held by men, corresponding to roughly two thirds of the jobs lost. As a comparison, in the Great Recession, this number was about three quarters. By contrast, one year after a positive fiscal shock, the level of employment has risen by about 250,000 jobs. Of these additional jobs, 156,000, or 62%, are held by women. Relative to about 46 million employed women on average, the 156,000 created jobs correspond to 0.32% whereas, for men, this number is 0.15%. Thus, fiscal expansions cause employment growth which is more than twice as strong for women than for men.

Taken together, our findings imply a policy trade-off: A contractionary non-fiscal shock causes a man-cession; aggregate employment falls and the employment of men falls disproportionately. If fiscal policy reacts to this and boosts aggregate employment, more women than men are brought

[8] Three quarters after the shock, the response of the gender ratio is negative in 94.1% of the accepted models.

[9] One year after the shock, 88.1% of the accepted models show a positive response of the gender employment ratio and this number increases to 97.0% in quarter 10 after the shock.

[10] The percentage changes in male and female employment can be determined from the responses of aggregate employment and the gender employment ratio. Let $\widehat{n}_F$, $\widehat{n}_M$, $\widehat{n} = \frac{n_F}{n}\widehat{n}_F + \frac{n_M}{n}\widehat{n}_M$, and $\widehat{n}_F - \widehat{n}_M$ denote the percentage trend deviations of female employment, male employment, total employment, and of the employment ratio, respectively. n, n_F, and n_M are the mean levels of total employment, female employment, and male employment, respectively. From our estimations, we take the medians of $\widehat{n}_F - \widehat{n}_M$ and calculate $\widehat{n}_M = \widehat{n} - \frac{n_F}{n}(\widehat{n}_F - \widehat{n}_M)$ and $\widehat{n}_F = \widehat{n} + \frac{n_M}{n}(\widehat{n}_F - \widehat{n}_M)$. The long-run means of total employment, female employment, and male employment in our sample are about 111 million, 46 million, and 65 million, respectively. Multiplying with relative changes gives the total job changes provided in the text.

into jobs which further destabilizes the gender composition of employment.

2.3 Sensitivity analysis

In this section, we briefly discuss a series of robustness checks for our baseline results. We first consider a number of specifications showing that our two main findings - contractionary non-fiscal shocks lead to man-cessions and expansionary fiscal shocks lead to stronger employment increases for women than for men - are not specific to the baseline specification of our VAR but are obtained for a wide range of re-specifications of the empirical model (details can be found in Appendix B; results are summarized in panels i)-vi) of Figure B1). Our results are robust to: i) including a set of further control variables, specifically, the real interest rate, average hourly earnings, private domestic spending, government spending, and tax revenues, ii) imposing the sign restrictions for fewer periods, iii) relaxing the restriction that the fiscal shock raises aggregate employment, and iv) restricting the sample period to 1979-2010, which is the sample period for our subsequent analysis of industry- and occupation-specific employment data in Section 3 using the Merged Outgoing Rotation Groups (MORG) files of the CPS. In each of these specifications, the female to male employment ratio reacts negatively to expansionary non-fiscal shocks in at least 90% of the accepted models. Likewise, in at least 90% of the accepted models, the gender employment ratio reacts positively to expansionary fiscal shocks.

Second, we use the Merged Outgoing Rotation Groups (MORG) files of the CPS to investigate whether the gender-specific fiscal policy effects are mainly driven by an expansion of government employment. The government wage bill is a major part of government consumption expenditures, and, at the same time, women are over-represented in government employment.[11] Therefore, the gender employment ratio may react to fiscal shocks because government employment is expanded. To investigate this hypothesis, we exclude employees working in the government sector and re-estimate our baseline specification with private employment only. Panel vii) of Figure B1 in Appendix B shows that the results from our baseline specification remain qualitatively unchanged. While there is a small composition effect stemming from the expansion of government employment, the gender-specific effects of fiscal policy are not entirely driven by this effect.[12]

[11] In the CPS MORG sample, the female share in government employment is about 55% and the female share in total employment is about 46%.

[12] To corroborate this, we considered a specification where we decompose the dynamics of the aggregate gender em-

Third, we re-estimate our baseline VAR replacing employment by hours worked. Data on gender-specific hours worked is constructed using the CPS-MORG data. Panel viii) of Figure B1 in the Appendix shows the results of this specification. For hours worked, we find the same qualitative responses as in our baseline specification where we used employment. Quantitatively, the female to male hours ratio reacts somewhat more strongly to both fiscal and non-fiscal shocks than the gender employment ratio, indicating dynamics at the intensive margin that reinforce the dynamics at the extensive margin.

Fourth, we consider an alternative identification of the VAR where we decompose the fiscal shock into spending hikes and tax cuts, employing opposite sign restrictions on the response of tax revenues. This decomposition allows us to assess whether the female-biased employment effects are a phenomenon specific to government spending shocks or whether also private sector decisions can be expected to play a role for understanding the documented effects. A detailed discussion of this specification can be found in Appendix B. Our baseline result that expansionary fiscal shocks foster job growth predominantly for women is confirmed for both kinds of fiscal shocks, see Figure B2.

3 Empirical drivers of man-cessions and gender-biased fiscal policy effects

In Section 2, we have shown that contractionary non-fiscal shocks lead to man-cessions, while expansionary fiscal shocks foster job growth predominantly for women. We now investigate potential explanations for these relations. In line with previous studies, we demonstrate that man-cessions are mainly driven by composition effects stemming from industry dynamics, reflecting that men tend to work in more cyclical industries (such as construction or manufacturing) than women. By contrast, we find that the female-biased employment effects after fiscal expansions are not largely driven by composition effects at the industry level. Instead, we find that fiscal shocks induce substantial changes in the gender composition within (rather than between) industry groups. We show that these within-industry effects are due to occupational dynamics within industries, in particular due to "pink-collar job booms" after fiscal expansions. In fact, we show that the gender-specific

ployment ratio into the dynamics of gender employment ratios within sectors (private and government) and the employment dynamics between sectors. In this specification, we find that a composition effect with respect to government employment is indeed one reason for the disproportionate increase in female employment. However, we find that this composition effect is quantitatively moderate.

effects of fiscal policy are driven by differential dynamics in occupation groups that differ with respect to their gender shares but arguably also with respect to their degree of substitutability with capital services in the production process. These relations will form the basis for the theoretical model developed in Section 4.

To investigate the industry-specific and occupation-specific employment effects of fiscal and non-fiscal shocks, we use the detailed Merged Outgoing Rotation Groups (MORG) files of the CPS.[13] This data allows us to construct 195 industry classifications which are consistently defined over the whole sample. In addition, we follow Autor and Dorn (2013) in constructing 332 occupation categories in the CPS MORG data which are consistently defined over the whole sample.[14] Due to a major change in the occupational classification system in 2011, the sample used in the various estimations discussed in this section ends in 2010Q4.[15]

3.1 What explains man-cessions?

Previous literature has documented that industry effects play an important role in explaining man-cessions, see, e.g., Hoynes, Miller, and Schaller (2012). These industry effects stem from the facts that men and women are not distributed equally among industries, and that industries are heterogenous with respect to their exposure to the cycle. Since men tend to work in more cyclical industries such as construction and manufacturing, they are more heavily affected by cyclical employment fluctuations. To identify potential composition effects resulting from different gender shares across industries, we distinguish between "female-dominated industries" and "non-female-dominated industries" (which we refer to as "other" industries). We categorize an industry as female-dominated if the average share of women in this industry is at least 60%.[16] We then estimate a VAR specification where we decompose the aggregate gender employment ratio into a between-industry component and two within-industry components: Between-industry effects (which affect the aggregate gender employment ratio via a composition effect) are measured through changes in the employment ratio between "female-dominated" and "other" industries. Within-industry

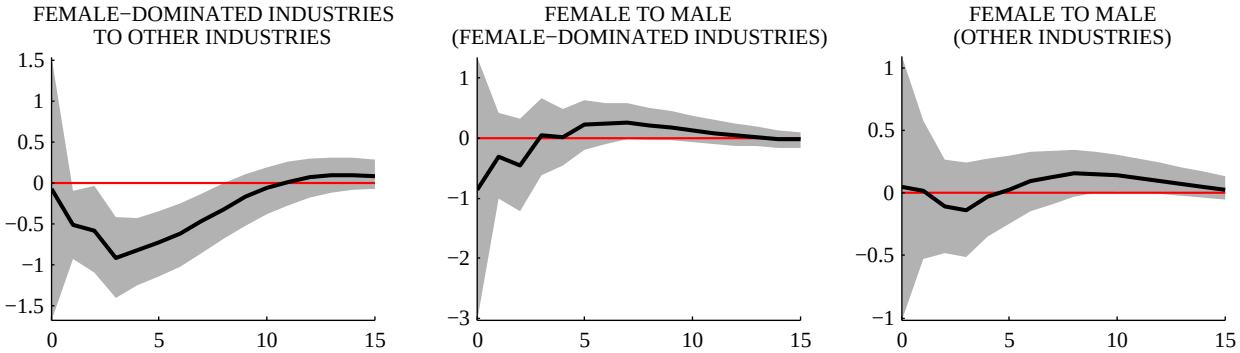
[13] In our baseline analysis, we used the aggregated CPS employment data provided by the BLS. We checked that aggregating the CPS MORG data yields virtually identical employment data as used in our baseline analysis.

[14] Their classification system provides a balanced panel of occupations covering the 1980, 1990, and the 2000 Census classifications by mapping Census occupation codes to a unified category system.

[15] In the robustness checks discussed in Section 2.3, we repeated our baseline estimations for this sample period. The results remain qualitatively unchanged.

[16] The female-dominated industries range from hotels and motels (female share 61.1%) to dressmaking shops (96.5%).

Figure 2: Between-industry and within-industry employment dynamics: Non-fiscal shock.



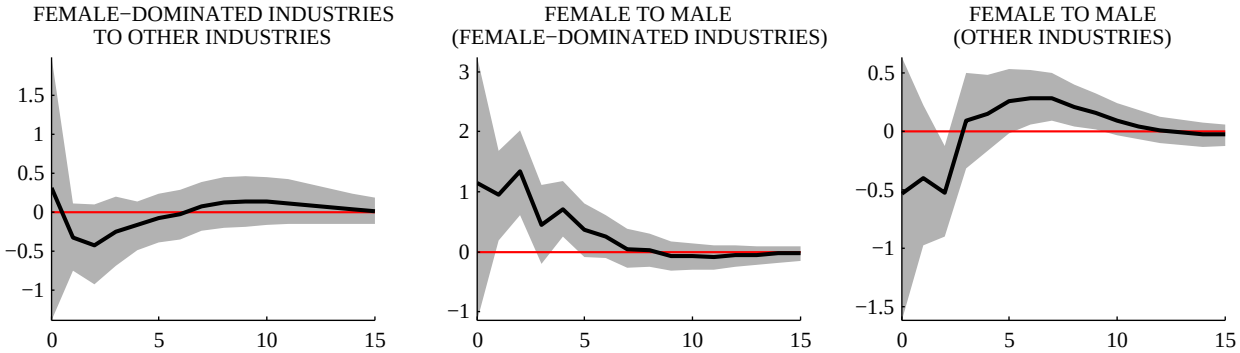
Notes: Impulse responses in VAR decomposing the dynamics of the gender employment ratio into between-industry dynamics and within-industry dynamics (non-fiscal shock; fiscal shock is shown in Figure 3). The solid lines are the median responses and the grey shaded areas show the 16th-84th percentiles of 10,000 estimated responses. The responses are expressed in percentage terms. On the horizontal axes, the horizon is given in quarters. The median impact response of GDP (not shown) is normalized to one percent.

changes in the gender ratio are captured by the female to male employment ratio within "female-dominated" industries and by the female to male employment ratio within "other" (i.e., non female-dominated) industries.

Figure 2 summarizes the responses to the non-fiscal shock (as before, we simultaneously identify a fiscal shock, the reactions to which will be discussed in the next subsection). To save on space, the figure only shows the reactions of the three employment ratios discussed above, which decompose the reaction of the aggregate gender employment ratio. The responses of the other variables in the VAR (primary deficit, output, and aggregate employment) are very similar as in our baseline specification from Section 2.

We find that the ratio of employment in female-dominated industries to employment in other industries is strongly counter-cyclical, see the left panel in Figure 2. Thus, composition effects resulting from between-industry dynamics are key for understanding man-cessions. By contrast, the gender ratios within industries do not react substantially to non-fiscal shocks (middle and right panels). This shows that the different employment dynamics of women and men in response to non-fiscal shocks are explained almost completely by the gender differences in the industry mix of employment. This is in line with previous evidence, e.g., Hoynes, Miller, and Schaller (2012) who consider employment cyclicality by gender and industry.

Figure 3: Between-industry and within-industry employment dynamics: Fiscal shock.



Notes: Impulse responses in VAR decomposing the dynamics of the gender employment ratio into between-industry dynamics and within-industry dynamics (fiscal shock; non-fiscal shock is shown in Figure 2). The solid lines are the median responses and the grey shaded areas show the 16th-84th percentiles of 10,000 estimated responses. The responses are expressed in percentage terms. On the horizontal axes, the horizon is given in quarters. The median impact response of GDP (not shown) is normalized to one percent.

3.2 What explains the female-biased employment effects of fiscal policy?

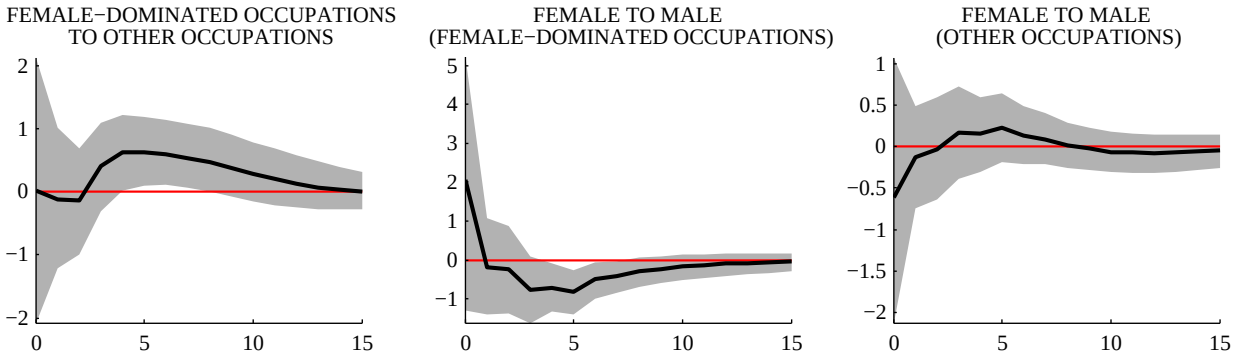
In the previous subsection, we have shown that industry effects are key for understanding mancessions. In principle, industry effects may also be responsible for the gender-specific employment reactions after fiscal shocks that we documented in Section 2: If the government mostly purchases goods and services produced in industries where women are employed disproportionately, such as education and health care, the aggregate female to male employment ratio may increase due to a composition effect.[17] Similarly, also changes in private demand caused by the fiscal shock can differ across industries. Next to these composition effects reflecting changes between industries, the female to male employment ratio can also change within industries.

Figure 3 again refers to the specification where we decomposed the aggregate gender employment ratio into between- and within-industry effects, this time showing the reactions to the fiscal shock. Interestingly, the figure shows that, after fiscal shocks, we do not observe an employment increase in female-dominated relative to other industries (left panel). Thus, after fiscal shocks, there is no evidence for composition effects at the industry level. Instead, the remaining two panels show that, after fiscal shocks, there are substantial changes in the gender composition within industry groups.[18] In particular, in both industry groups, we observe disproportionate surges in

[17] Note, however, that our interest lies on the industry mix of the created jobs rather than on the industry mix of the goods and services purchased by the government.

[18] Note that these results do not depend on the specific threshold value for defining an industry as "female-dominated". For instance, we obtain similar results when using the thresholds 50% or 70%, respectively.

Figure 4: Between-occupations and within-occupation employment dynamics: Fiscal shock.



Notes: Impulse responses in VAR decomposing the dynamics of the gender employment ratio into between-occupations dynamics and within-occupation dynamics, occupations grouped by gender share. Female-dominated occupations are defined as occupations with a female employment share larger than 60%. The solid lines are the median responses and the grey shaded areas show the 16th-84th percentiles of 10,000 estimated responses. The responses are expressed in percentage terms. On the horizontal axes, the horizon is given in quarters. The median impact response of GDP (not shown) is normalized to one percent.

female employment, as we do in the aggregate.

A natural candidate for explaining these within-industry employment dynamics are dynamics at the level of occupations. In fact, a link between occupational dynamics and the gender composition of employment has been discussed recently in the context of the Great Recession in the U.S.. Specifically, traditionally female-dominated (so-called "pink-collar") occupations appear to have played an important role during the recovery after the Great Recession. For example, a Data Brief of the National Employment Law Project from August 2012 states that "occupations that grew the most during the recovery include retail salespersons, food preparation workers, ... , waiters and waitresses, personal and home care aides, and office clerks and customer representatives." While this phenomenon has attracted considerable attention under the keyword "low-wage recovery", some commentators have used the term "pink-collar job boom" to highlight its gender dimension, see, e.g., David Francis' contribution in U.S. News (Sep. 10, 2012).

To investigate the role of "pink-collar job booms", we proceed in two steps. First, we repeat our previous decomposition analysis using a classification in terms of female-dominated and non female-dominated ("other") occupations rather than industries.[19] Second, we consider major occupation groups that differ with respect to their typical tasks.

[19] Using the same threshold value as for the industry evaluations before, we classify an occupation as female-dominated if the average female employment share is at least 60%. The so-defined pink-collar occupations range from archivists (female share 60.4%) to dental hygienists (98.6%).

Figure 4 shows the responses to the fiscal shock from the first specification (as before, we simultaneously identify a non-fiscal shock also in this specification). The left panel shows that, after fiscal expansions, employment in female-dominated occupations rises more strongly than employment in other occupations. This raises the aggregate gender employment ratio due to a composition effect. Interestingly, we do not observe a significant change in the gender employment ratio within the non female-dominated occupation group, see the right panel in Figure 4. Note that there is even a significant reduction in the female to male employment ratio within female-dominated occupations. Apparently, fiscal expansions induce men to pick up jobs in traditionally female-dominated occupations.[20] Within neither of the two occupation groups, there is a significant rise in female employment relative to male employment. Therefore, we can conclude that the composition effect with respect to occupations, visible in the left panel of Figure 4, is the main driver of the female-biased employment effects of fiscal policy in the aggregate.

We now examine what types of occupations are primarily female-dominated and primarily male-dominated, respectively, and what distinguishes the two types of occupations. To do so, we follow, e.g., Hoynes, Miller, and Schaller 2012, and categorize occupations in three major occupation groups. Specifically, we distinguish between "high skill, "blue collar", and "clerical/services" occupations, respectively. Table 1 shows that "high skill" occupations are more or less distributed evenly across genders. By contrast, "blue collar" occupations are strongly male-dominated (the share of male workers is 81%) and "clerical/services" occupations are strongly female-dominated (the share of female workers is 70%). Recognizing the high share of women in clerical and service occupations, these occupations are often called "pink-collar" occupations. Importantly, the table shows that, also at a more disaggregated level, i.e. within subcategories, blue-collar occupations are predominantly held by men while pink-collar occupations are mostly held by women.

As we have already shown that employment in female-dominated occupations increases disproportionately after fiscal expansions, the gender shares in Table 1 suggest that these disproportionate employment gains are a consequence of "pink-collar job booms" (since women are over-represented in these occupations). To corroborate this, we estimate a final VAR specification where we compare employment gains in blue-collar and pink-collar occupations, respectively. Specifically, we

[20] Bansak, Graham, and Zebedee (2012) have documented that the gender desegregation of occupations is accelerated in upswings, which is in line with our results.

Table 1: Gender shares in major occupation groups.

	share female	share male
High skill		
Managers/prof/tech/finance/public safety	0.47	0.53
Blue collar	**0.19**	**0.81**
Production/craft	0.23	0.77
Transport/construct/mech/mining/farm	0.11	0.89
Machine operators/assemblers	0.43	0.57
Pink collar (clerical/services)	**0.70**	**0.30**
Clerical/retail sales	0.74	0.26
Service occupations	0.63	0.37

re-estimate our baseline specification, replacing the female to male employment ratio by the employment ratio between pink-collar and blue-collar occupations. Figure 5 shows the responses to the fiscal shock (a non-fiscal shock is identified as well). We find that expansionary fiscal shocks foster employment growth predominantly in pink-collar occupations and less so in blue-collar occupations and, hence, induce a "pink-collar job boom".

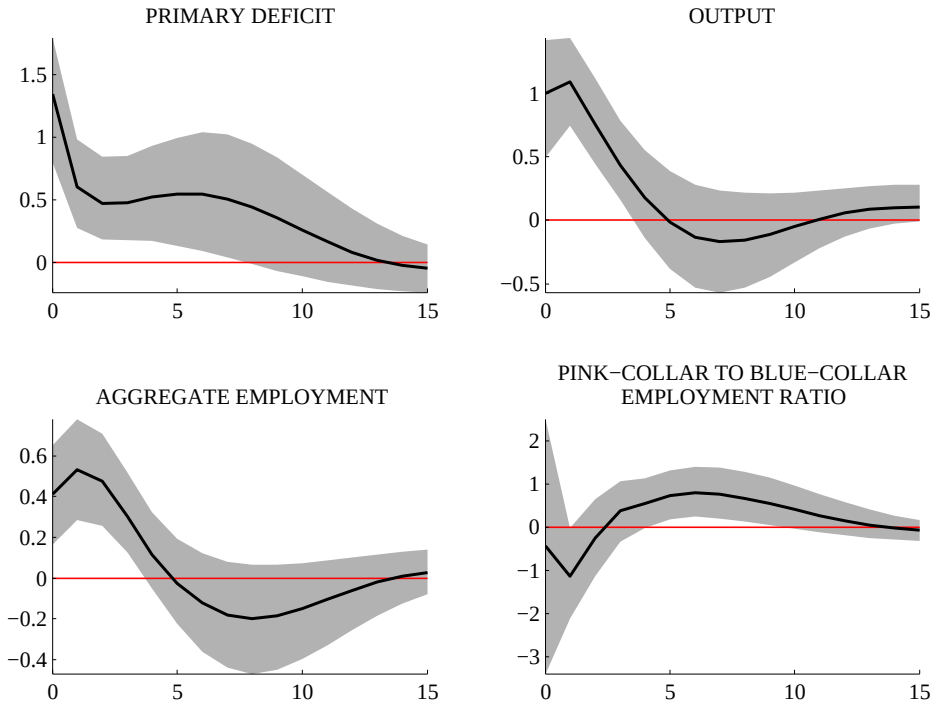
We have performed a number of robustness checks that confirm that expansionary fiscal shocks trigger pink-collar job booms. Most importantly, we observe disproportionate surges of pink-collar employment also within industry groups (see Figure B3 in Appendix B) and among male workers (see Figure B4 in Appendix B).

4 Explaining occupational employment dynamics

In the previous section, we have shown that expansionary fiscal impulses foster employment growth predominantly in pink-collar occupations which are mostly held by women. To understand why firms adjust their demand for labor in different occupations, it is important to understand what distinguishes pink-collar occupations from blue-collar occupations, apart from differences in gender shares. Put differently, we provide an explanation that builds on the different dynamics of labor demand faced by workers in different occupations. In Appendix C, we show that a (pure) labor-supply based argument seems rather unconvincing given the empirical evidence.

In this section, we will first argue that a fundamental difference between the two occupation groups is their respective role in the production process. Specifically, the short-run substitutability between labor and capital services differs across occupation groups. Then, in Section **??**, we develop a business-cycle model that can explain the documented pink-collar job booms in response to fiscal

Figure 5: Impulse responses to fiscal shock in VAR containing the pink-collar to blue-collar employment ratio.



Notes: Pink-collar occupations are service occupations and clerical/retail sales occupations. Blue collar occupations are production/craft, transport/construction/mechanics/mining/farming, and machine operators/assemblers. The solid lines are the median responses and the grey shaded areas show the 16th-84th percentiles of 10,000 estimated responses. The responses are expressed in percentage terms (for the defict, in terms of output). On the horizontal axes, the horizon is given in quarters. The median impact response of GDP is normalized to one percent.

expansions.

Our model considers a representative industry where we distinguish between two occupation groups. Therefore, our model does not aim at explaining man-cessions. Our previous empirical analysis has shown that man-cessions are largely explained by shifts in the industry mix of employment, see Figure 2. In our model, we focus on explaining between-occupation dynamics occurring within industries. Specifically, the scope of the model is to explain why fiscal expansions trigger pink-collar job booms.

4.1 Differential substitutability of blue-collar and pink-collar labor with capital

The mechanism highlighted in our model will rest on the assumption that occupation groups are subject to a different substitutability between labor and capital services. While Autor and Dorn (2013) have employed a production technology with these properties to explain long-run job polarization in the U.S., we account for such technology in a business-cycle context. Our model builds on the relation that, in the short run, labor provided by blue-collar occupations is more easily substitutable with capital than labor provided by pink-collar occupations.

To motivate this relation, consider labor supplied by workers in blue-collar occupations. A first example are truck drivers which belong to the largest occupation group within "transport and related occupations" (compare Table 1) and consists of 94.4% men. In response to temporary demand boosts, loading trucks with more cargo which causes an increased depreciation of trucks is an alternative to using more labor. A second example are machinists, the second largest occupation group within "production and craft" occupations (95.2% men). Machine tools can be used more intensely in the short run, raising their depreciation, as an alternative to employing more machinists.

By contrast, labor supplied by workers in pink-collar occupations is a relatively poor substitute to capital services in the short run. For example, the services provided by "health and nursing aides" (the largest service occupation, 89.2% women) includes a substantial share of direct human interaction which is difficult to provide by machines. As an example for clerical occupations consider "secretaries and stenographers", the largest clerical occupation group which consists of 98.4% women. It is possible that tasks performed by workers in these occupations are performed

by new generations of better or cheaper machines in the long run but it is rather implausible that short-run increases in demand can be satisfied by using existing machines more intensely. For example, using the same dictaphone for longer each day will not raise output unless the time input of the secretary is raised more or less proportionately.

Note that our classification in terms of blue-collar and pink-collar occupations is not identical to Autor and Dorn's (2013) classification in terms of "routine tasks" and "manual tasks". Some occupations are classified as close substitutes to capital in Autor and Dorn (2013) while we classify these occupations as rather complementary to capital services. The reason is that Autor and Dorn (2013) consider a long-run perspective, while our analysis relates to the short run. For instance, our previous example of services provided by secretaries being difficult to be replaced by capital refers to the short run, while, in the long run, this occupation may well be substitutable by capital due to its routine work nature, e.g. through technological progress in computer technology.

In the following, we develop a business-cycle model based on differences in the short-run substitutability of capital services with blue-collar and pink-collar labor, respectively, that is able to explain the documented asymmetries in employment dynamics across occupations after fiscal expansions.

4.2 The model

The model is a standard New Keynesian business-cycle model to which we add occupational labor and different degrees of substitutability between inputs. To replicate the empirical evidence on the effects of fiscal shocks on output, aggregate employment, and relative occupational employment, the model needs two key elements. First, firms must raise their demand for capital services more than proportionately with output after a fiscal expansion. In our model, firms behave like this because relative factor costs change in favor of capital use compared to labor. This is a consequence of a relatively elastic short-run supply of capital services compared to labor and, in the case of government spending expansions, of a limited wealth effect on labor supply. The second key element is that blue-collar labor is a closer substitute to capital services than pink-collar labor. Firms that substitute away from labor toward capital services due to the relative cost shift described above will then decrease their demand for blue-collar labor relative to pink-collar labor. Together with

an overall rise in employment stemming from the increase in aggregate demand after the fiscal stimulus, this generates a pink-collar job boom.

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 $n_{j,t}^b$ and pink-collar labor $n_{j,t}^p$.

Firm j uses the following nested CES production technology:

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

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

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

The parameter $\phi > 0$ measures the elasticity of substitution between capital services and blue-collar labor in production, the parameter $\theta > 0$ measures the elasticity of substitution between the input bundle $v_{j,t}$ and pink-collar labor in production, $\alpha \in (0,1)$ 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 $\log a_t = (1-\rho_a)\log a + \rho_a \log a_{t-1} + \varepsilon_t^a$, where ε_t^a is $i.i.d.N(0, \sigma_{\varepsilon^a}^2)$. This production technology resembles the one used by Autor and Dorn (2013).[21] The production function (1) allows for different degrees of substitutability between capital services on the one hand and pink-collar or blue-collar labor on the other hand. For $\phi > \theta$, blue-collar labor is the closer

[21] 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 is distributed relatively evenly across genders, see Table 1.

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 elasticities of substitution between any two factors is one.

The firm chooses $n^b_{j,t}$, $n^p_{j,t}$, $\tilde{k}_{j,t}$ to minimize real costs

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

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 terms inside the brackets 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.[22] 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 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 $p_t = \left(\int_0^1 p^{1-\epsilon}_{j,t} di \right)^{1/(1-\epsilon)}$ is the price index. The term $\frac{\psi}{2} \left(\frac{p_{j,t}}{p_{j,t-1}} - 1 \right)^2 y_t$ 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.

[22] 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.

First-order conditions of the cost minimization problem read as follows:

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

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

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

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

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

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

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

Define $\pi_t = p_t / p_{t-1}$ as the gross inflation rate. The first-order condition of the profit maximization problem is given by

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

which, in the absence of price adjustment costs ($\psi = 0$), collapses to the mark-up pricing rule $p_t = \frac{\epsilon}{\epsilon-1} mc_t^n$, where $mc_t^n = p_t mc_t$ denotes nominal marginal costs and $\frac{\epsilon}{\epsilon-1}$ is the desired price mark-up.

Households. The economy consists of a continuum of infinitely-lived households, with mass normalized to one. Each household consists of two members one of which works in a pink-collar occupation and the other one works in a blue-collar occupation. We abstract from occupational labor mobility which is an empirically plausible assumption at business-cycle frequency. We consider a unitary household that cares about its total consumption level c_t and receives disutility from both members' employment, 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 emprical evidence showing that similar developments occur at both margins, see Section 2.3. 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 takes the form as proposed by Jaimovich and Rebelo (2009):

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

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 $\chi = 0$. 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

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

where c_t is consumption, i_t is investment into physical capital that is owned by households, b_t is the beginning-of-period stock of nominal government bonds, τ_t is the income tax rate, k_t 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

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

where $\delta \in (0, 1)$ is the capital depreciation rate and $\frac{\kappa_i}{2}(i_t/i_{t-1} - 1)^2$ 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 $\tilde{k}_t = u_t k_t$. 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 crucial for the ability of the model to replicate the empirical evidence, as shown below.

Households choose $\{c_t, i_t, u_t, n_t^p, n_t^b, k_{t+1}, b_{t+1}, x_t\}_{t=0}^{\infty}$, taking as given $\{w_t^p,\ w_t^b,\ p_t,\ r_t^k,\ r_t,\ d_t,\ s_t,\ \tau_t\}_{t=0}^{\infty}$ and the initial wealth b_0, k_0 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 read

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

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

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

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

$$\begin{aligned} 1 = q_t & \left(1 - \frac{\kappa_i}{2} \left(\frac{i_t}{i_{t-1}} - 1 \right)^2 - \kappa_i \left(\frac{i_t}{i_{t-1}} - 1 \right) \frac{i_t}{i_{t-1}} \right) \\ & + \beta\,\mathrm{E}_t \left\{ \frac{\lambda_{t+1}}{\lambda_t} q_{t+1} \kappa_i \left(\frac{i_{t+1}}{i_t} - 1 \right) \left(\frac{i_{t+1}}{i_t} \right)^2 \right\}\,, \end{aligned} \tag{16}$$

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

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

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

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

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):

$$\frac{b_{t+1}}{p_t} = def_t + (1 + r_{t-1})\frac{b_t}{p_t},$$

where def_t denotes the primary fiscal deficit, given by

$$def_t = g_t + s_t - \tau_t \left(w_t^b n_t^b + w_t^p n_t^p + r_t^k \tilde{k}_t^s \right). \tag{21}$$

Government spending, g_t, and taxes, τ_t, follow exogenous AR(1) processes: $\log g_t = (1-\rho_g)\log g + \rho_g \log g_{t-1} + \varepsilon_t^g$, where ε_t^g is $i.i.d.N(0, \sigma^2_{\varepsilon^g})$ and $\tau_t = (1-\rho_\tau)\tau + \rho_\tau \tau_{t-1} + \varepsilon_t^\tau$, where ε_t^τ is $i.i.d.N(0, \sigma^2_{\varepsilon^\tau})$. In order to guarantee the stability of government debt, transfers follow the rule $\log(s_t) = (1 - \rho_s)\log(s) + \rho_s \log(s_{t-1}) - \gamma_b \cdot d(b_t/p_t)/y$, where $d(b_t/p_t)/y$ denotes deviations of real debt from its steady state, expressed in terms of steady-state output y, and 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:

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

4.3 Analytical results from a simplified model version

We now investigate the effects of fiscal shocks in the model, i.e. innovations to government spending and taxes. We proceed in two steps. In this section, we consider a simplified version of the model which allows us to provide analytical results. We use this model version to understand the basic mechanisms driving the responses of the pink-collar to blue-collar employment ratio. In the next section, we consider a calibrated version of the model and present numerical results.

To facilitate the derivation of analytical results, we simplify the model in this section by applying the parameter values $\rho_a = \rho_g = \rho_\tau = \rho_s = 0$, $\delta_y = 0$, $\kappa_i \to \infty$, $\delta = 0$, $\sigma \to 1$, $\chi = 0$, $\kappa_n = 0$, and $\theta \to 1$, which imply that there is no autocorrelation of shocks or fiscal policy, no output reaction of monetary policy, 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 if $\Delta > 1$ and that blue-collar labor is the closer substitute to capital services than pink-collar labor if $\phi > 1$.

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

$$\widehat{y}_t = \Lambda^{-1} \cdot \left(\Delta^{-1} + 3\phi + 5\Delta^{-1}\phi + 7\right) \cdot \left[g \cdot \widehat{g}_t - \Gamma \cdot c \cdot \widehat{\tau}_t\right] , \tag{23}$$

where hats indicate log deviations from steady state and

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

where $\Gamma = \delta_\pi \cdot \kappa \cdot \lambda^2 > 0$ and κ is the slope of the linearized Phillips curve, see Appendix C for a detailed derivation of the solution of the simplified model. A fiscal stimulus – i.e., a rise in the term in square brackets on the right-hand side of (23) either through a rise in government spending or a cut in income taxes or a combination of both – raises output if $\Lambda > 0$. Then, also both types of employment and hence aggregate employment increase if $\widehat{g}_t > 0$ and/or $\widehat{\tau}_t < 0$, see Appendix C.

Our primary focus is on the reaction of the ratio of pink-collar to blue-collar labor to fiscal shocks. In log-linear terms, this reaction is described by

$$\widehat{n}_t^p - \widehat{n}_t^b = \frac{2}{\Lambda \cdot \Delta} \cdot (\Delta - 1) \cdot (\phi - 1) \cdot \left[g \cdot \widehat{g}_t - \Gamma \cdot c \cdot \widehat{\tau}_t\right] . \tag{24}$$

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 blue-collar labor is the 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 input becomes cheaper relative to labor input.

If the fiscal stimulus takes the form of a government spending expansion, 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 the fiscal stimulus takes the form of a tax cut, the relative factor price shift occurs because the induced decline in factor prices is stronger for the production factor that is supplied more elastically (which are capital services). 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.[23]

The mechanism highlighted above hence hinges on two key assumptions. First, the supply of capital services is relatively elastic compared to labor. Second, blue-collar labor is a closer substitute to capital services than pink-collar labor. There is strong support for both assumptions. The elasticity of capital utilization is usually estimated to be considerably larger than Frisch labor supply elasticities.[24] Concerning the relative substitutability of pink-collar and blue-collar labor with capital services, we have presented arguments in Section 4.1 why blue-collar labor is a closer substitute to capital services than pink-collar labor in the short run.

4.4 Numerical results

While the results of the previous section help to understand the basic mechanism, we now investigate the effects of fiscal shocks in a calibrated version of our model. Rather than matching the exact profiles of the estimated impulse responses from the empirical VAR model, our aim is to investigate whether the calibrated model generates impulse responses that are generally consistent with our empirical evidence.

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

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

[24] See, for example, Schmitt-Grohé and Uribe (2012), Smets and Wouters (2007), or Christiano, Eichenbaum, and Evans (2005).

a steady-state labor supply normalized to $n^p = n^b = 1$. 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 discuss results for two alternative values of the wealth elasticity of labor supply, $\chi = 0.25$ and $\chi = 0.5$. 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, the supply of capital services is more elastic than the supply of labor, $\Delta > \eta$.

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 $\beta = 0.9927$ that is 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 0.87, consistent with its sample mean. This requires $\alpha = 0.7$ and $\gamma = 0.09$. 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) for the U.S. economy. The responsiveness of government transfer to changes in government debt is calibrated to $\gamma_{sb} = 0.1$ so as to insure debt sustainability. The autocorrelation of the exogenous processes is set to $\rho_j = 0.9$ for $j = a, g, \tau$. 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 the primary fiscal deficit def_t, output y_t, aggregate employment $n_t^p + n_t^b$, and the ratio of employment in pink-collar to blue-collar occupations, n_t^p/n_t^b, to the fiscal shocks as summarized in Figure 6. Impulse responses are expressed in percentage deviations from steady state or, in case of the deficit, of steady-state output. Panel (a) of Figure 6 depicts responses to a government spending expansion, Panel (b) depicts responses to a cut in income taxes. 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).[25]

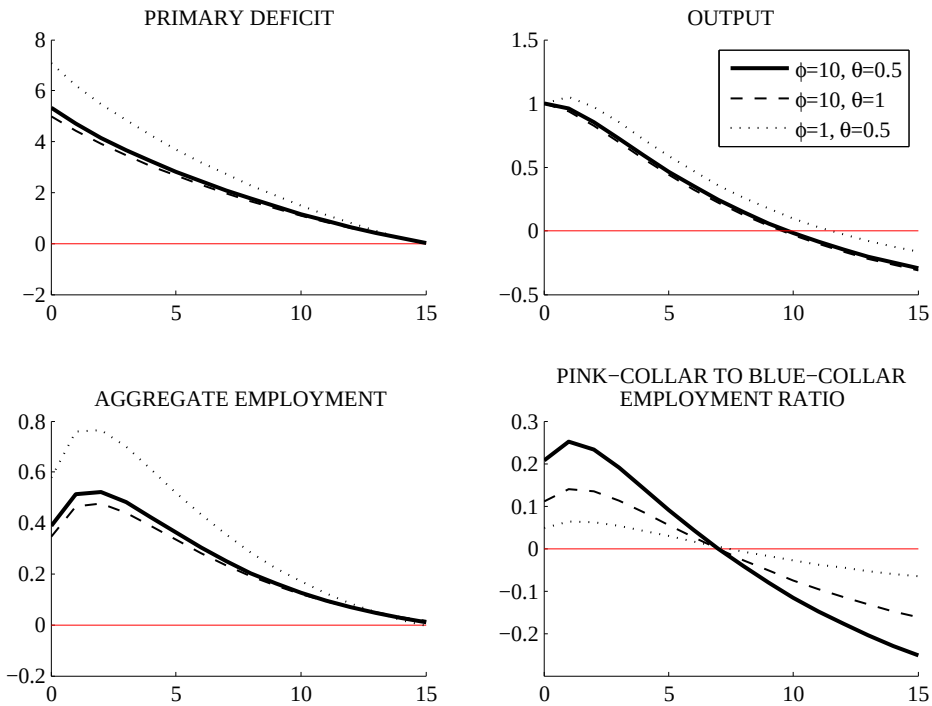
The lower right panels of Figure 6(a) and 6(b) show that both types of fiscal expansions trigger a pink-collar job boom, i.e. employment in pink-collar occupations rises more strongly than employment in blue-collar occupations. This result is in line with both, the empirical evidence presented in Section 2 and 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.[26] This relative price movement is due to labor supply being less elastic than the supply of capital services. The disproportionate increase in capital services in turn lowers the demand for its substitute, i.e. blue-collar labor, relative to pink-collar labor. 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 stronger is this effect and the more pronounced is the pink-collar job boom.

[25] Note that shock sizes are re-scaled such as to generate a change in GDP by one percent for each ϕ.

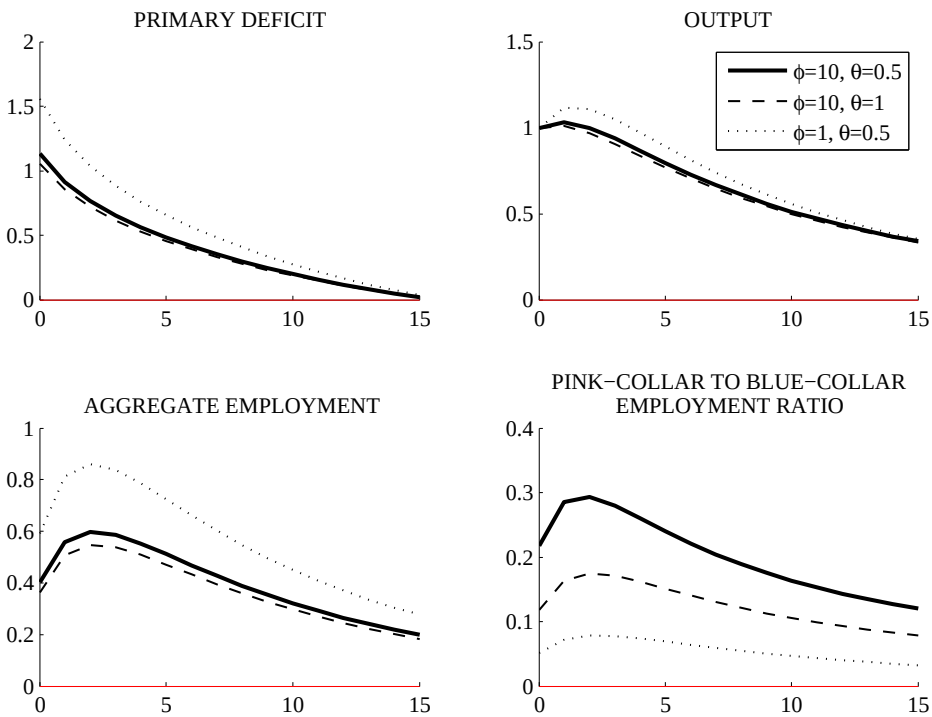
[26] In line with this, the VAR specification where we control for hourly earnings and real interest rates, see Section 2.3, shows that hourly earnings rise relative to interest rates in response to expansionary fiscal shocks.

Figure 6: Impulse responses.

(a) Spending shock

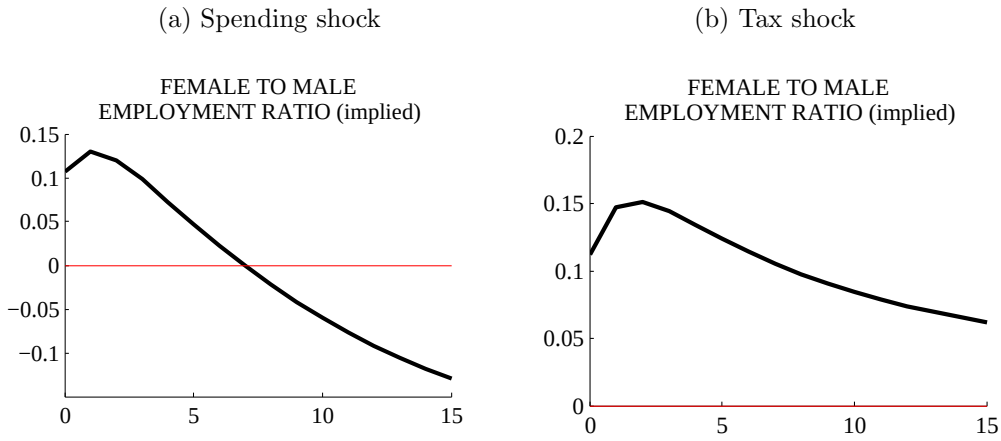


(b) Tax shock



Notes: The responses are expressed in percentage terms. On the horizontal axes, the horizon is given in quarters. Panel (a) shows model-implied impulse responses to a rise in government spending. Panel (b) shows model-implied impulse responses to a cut in income taxes. The size of the innovations are normalized such that the response of output is one percent on impact.

Figure 7: Reactions of the gender employment ratio implied by the reaction of the occupation employment ratio via a composition effect.



Notes: Implied responses are calculated under the assumption that the gender shares in the two occupation types are constant at the levels shown in Table 1. The impact response of output (not shown) is normalized to one percent.

Finally, we relate the model results concerning the pink-collar to blue-collar employment ratio to the estimated dynamics of the gender employment ratio from our VAR analysis discussed in Section 2. Specifically, we quantify the model-implied composition effect on the gender employment ratio. Figure 7 shows the dynamics of the female to male employment ratio which are implied via a composition effect by the dynamics of the pink-collar to blue-collar employment ratio. The displayed responses are based on our baseline calibration and assume that the gender shares in the two occupation groups are constant at the levels shown in Table 1. As women are over-represented in pink-collar occupations, the female to male employment ratio rises in pink-collar job booms. Quantitatively, the model-implied responses of the gender employment ratio are broadly in line with the empirical response of the female to male employment ratio displayed in Figure 1. Compared to the strongest significant response, the spending shock and the tax shock in our model generate about 61% and 77%, respectively, of the empirical change in the gender employment ratio.

4.5 Sensitivity analysis

In this section, we first illustrate how the parametrization of the wealth elasticity of labor supply χ affects our results. Second, we show that, in the model, not all upswings are associated with a pink-collar job boom as fiscal expansions are.

For spending expansions, the associated wealth effect dampens the impact on the employment

ratio if $\chi > 0$, see the lower right panel of Figure C1(a) in the Appendix which compares our baseline results for $\chi \approx 0$ to the results for two alternative calibrations, $\chi = 0.25$ and $\chi = 0.5$. The wealth effect leads to a rightward shift of the labor supply curve which tends to reduce wages. If this effect is strong, firms substitute away from capital services which reverts the effects described above. After tax cuts, by contrast, pink-collar employment rises disproportionately, irrespective of the wealth elasticity ζ. Here, the surge in the pink-collar to blue-collar employment ratio even increases with a rising wealth elasticity. The reason is that, after tax cuts, a positive wealth effect puts upward pressure on real wages. In turn, this enforces firms' substitution toward capital services.

Next, we investigate the effects of labor productivity shocks in our model. The purpose of this exercise is to show that, in our model, not all expansions are associated with pink-collar job booms by construction. Specifically, we show that favorable labor productivity shocks trigger a decline rather than an increase in the pink-collar to blue-collar employment ratio. We first demonstrate this in the simplified model and present results from the calibrated baseline model afterwards.

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 substitute to capital services. 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 this case, the output reaction to a labor productivity shock is given by

$$\widehat{y}_t = \frac{2\Delta^{-1} + 2\phi + 10\Delta^{-1}\phi + 10}{3\Delta^{-1} + \phi + 7\Delta^{-1}\phi + 5} \cdot \widehat{a}_t, \tag{25}$$

and the reaction of the pink-collar to blue-collar employment ratio can be expressed as

$$\widehat{n}_t^{\,p} - \widehat{n}_t^{\,b} = \frac{4}{3 + \Delta\phi + 7\phi + 5\Delta} \cdot (1 - \phi) \cdot \widehat{a}_t. \tag{26}$$

Hence, output rises unambiguously in $\widehat{a}$. Under the assumptions mentioned above, the pink-collar to blue-collar employment ratio falls in response to a positive labor productivity shock ($\widehat{a} \neq 0$, $\widehat{g} = 0$). 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 ($\phi > 1$), capital services are supplied more elastically than labor ($\Delta > 1$), 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.

Also in the calibrated model, the shock to labor productivity triggers a reaction of the pink-collar to blue-collar employment ratio that goes into the opposite direction than the one triggered by fiscal shocks. After an increase in labor productivity a_t, employment in blue-collar occupations rises disproportionately, see Figure C2 in the Appendix. The easier it is to substitute blue-collar labor for capital services, the stronger is the relative increase in blue-collar employment.

5 Conclusion

In this paper, we have identified the employment effects of fiscal and non-fiscal shocks by gender. Contractionary non-fiscal shocks lead to man-cessions, i.e. to disproportionate job losses for men. By contrast, fiscal expansions lead to a disproportionate surge in the employment of women relative to that of men. Thus, fiscal stimuli further destabilize the gender composition of employment in recessions.

The gender-biased employment effects of fiscal policy are the result of pink-collar job booms, i.e., disproportionate employment surges in clerical and service occupations which are mostly held by women. By contrast, industry dynamics are important for understanding why man-cessions occur in the first place.

We have presented a business-cycle model that explains the occupational employment dynamics triggered by fiscal expansions as a consequence of occupation differences in the substitutability between capital and labor. In this model, fiscal expansions induce pink-collar job booms in line with what is found in the data. Since women are over-represented in pink-collar occupations, this

translates into disproportionate employment growth for women in response to fiscal shocks.

As a policy implication, our results suggest that a fiscal policy aiming at stabilizing the composition of employment along with its level may want to target stimulus packages toward male-dominated industries. This could offset the female-biased employment effects which result from the occupation dynamics triggered by fiscal shocks.

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A Data appendix

A.1 Data taken from official statistics

Table A1: Data sources

Series Title	Series ID	Source
Civilian Noninstitutional Population	CNP16OV	BLS
Civilian Employment-Population Ratio	EMRATIO	BLS
Employment-Population Ratio – Women	LNS12300002	BLS
Employment-Population Ratio – Men	LNS12300001	BLS
Government Current Expenditures: Interest Payments	A180RC1Q027SBEA	BEA
Gross Domestic Product	GDP	BEA
Gross Domestic Product: Implicit Price Deflator	GDPDEF	BEA
Net Government Saving	TGDEF	BEA
Average Hourly Earnings of Production and Nonsupervisory Employees: Total Private	AHEPTI	BLS
Current Tax Receipts	W054RC1Q027SBEA	BEA
Effective Federal Funds Rate	FEDFUNDS	BFED
Government Consumption Expenditures	A955RC1Q027SBEA	BEA
Gross Government Investment	A782RC1Q027SBEA	BEA
Gross Private Domestic Investment	GPDI	BEA
Personal Consumption Expenditures	PCE	BEA

Notes: BLS: U.S. Bureau of Labor Statistics, BEA: U.S. Bureau of Economic Analysis, BFED: Board of Governors of the Federal Reserve System.

Table A2: Definition of variables

Variable	Definition	Description
Primary Deficit	$\text{hp}\left(\frac{-(TGDEF+A180RC1Q027SBEA)}{\text{mean}(GDP)}\right)$	cyclical component of real primary government deficit relative to average GDP
Output	$\text{hp}\left(\log\left(\frac{(GDP)}{(GDPDEF)\cdot(CNP16OV)}\right)\right)$	cyclical component of log real GDP per capita
Aggregate Employment	$\text{hp}\left(\log\left(EMRATIO\right)\right)$	cyclical component of log aggregate employment
Female-male Employment Ratio	$\text{hp}\left(\log\left(\frac{LNS12300002}{LNS12300001}\right)\right)$	cyclical component of log employment ratio between women and men
Government Spending	$\text{hp}\left(\log\left(\frac{(A955\ldots)+(A782\ldots)}{GDPDEF\cdot CNP16OV}\right)\right)$	cyclical component of log real government spending per capita
Tax Revenues	$\text{hp}\left(\log\left(\frac{W054RC1Q027SBEA}{GDPDEF\cdot CNP16OV}\right)\right)$	cyclical component of log real government tax revenues per capita
Real interest rate	$\text{hp}\left(\frac{FEDFUNDS}{100}-\log\left(\frac{GDPDEF(+1)}{GDPDEF}\right)\cdot 4\right)$	cyclical component of annualized real interest rate
Private Domestic Spending	$\text{hp}\left(\log\left(\frac{(PCE+GPDI)}{(GDPDEF)\cdot(CNP16OV)}\right)\right)$	cyclical component of log real private domestic spending
Hourly Earnings	$\text{hp}\left(\log\left(\frac{AHEPTI}{GDPDEF}\right)\right)$	cyclical component of log real hourly earnings

Notes: The function hp stands for Hodrick-Prescott (HP) filter using a smoothing parameter of 1600. (+1) indicates a one-quarter lead.

A.2 Data constructed from CPS-MORG

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 (25,000 or more individuals per month) and can be downloaded from the National Bureau of Economic Research: `http://www.nber.org/morg/annual/`.

We checked that aggregating the monthly CPS-MORG micro data to quarterly, seasonally adjusted time series yields virtually identical time series as published by the BLS, which we used in our baseline estimations. 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 working. To determine whether an individual is working in the private or public sector, we use the CPS information on the current job held in the reference week (class of worker). In our robustness check using data on hours worked instead of employment, we use the CPS information on how many hours the individual worked last week at all jobs. In the evaluations using industry-specific or occupation-specific employment data, we drop observations with missing information on these variables. The major occupation groups we consider in Table 1 follow the 2010 Census classification.

B Robustness checks for the empirical analysis

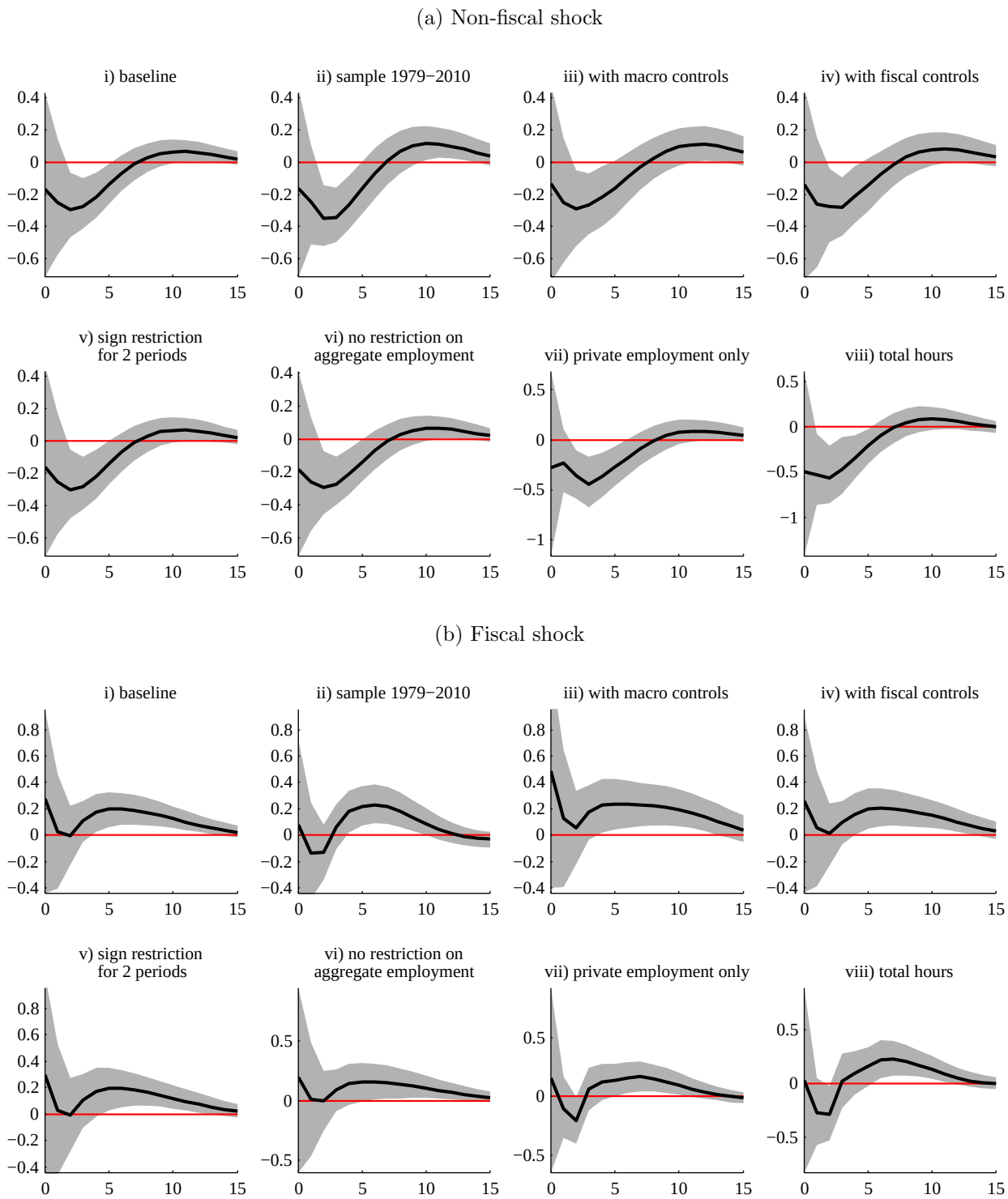
Robustness checks for baseline specification. Figure B1 summarizes the results from various robustness checks for our finding that fiscal expansions lead to a disproportionate increase in the employment of women and that contractionary non-fiscal shocks lead to man-cessions. Panels i) in Figure B1(a) and B1(b) show our baseline specification for the sake of comparison. Our main results are robust to a change in the sample period, see Panels ii), to including a set of macroeconomic controls (real interest rate, hourly earnings, and private domestic spending), see Panels iii), to including fiscal controls (government spending and tax revenues), see Panels iv), to imposing the sign restrictions for two instead of four quarters, see Panels v), and to relaxing the sign restriction on aggregate employment, see Panels vi). Note that, in all specifications, the female to male employment ratio reacts negatively to expansionary non-fiscal shocks in at least 90% of the accepted models. Likewise, in at least 90% of the accepted models, the ratio reacts positively to expansionary fiscal shocks.

Exclude government employment. Panels vii) of Figure B1(a) and B1(b) show the results from a specification where we exclude employees working in the government sector, thus including private employment only. The sample for this specification starts in 1979Q1 and ends in 2013Q4 (the information on private employment is taken from the CPS MORG files). The results from our baseline specification remain qualitatively unchanged.

Total hours worked. Panels viii) of Figure B1(a) and B1(b) show results from a VAR where we re-estimate our baseline specification using hours worked instead of employment. The sample period is 1979-2013. The results from our baseline specification are qualitatively unchanged. Quantitatively, the reaction of the gender ratio in total hours worked (reflecting both, the intensive and extensive margin) is more pronounced than the reaction of the gender employment ratio. This holds for both the fiscal and non-fiscal shock, respectively. This indicates that the gender-specific dynamics at the intensive margin go into the same direction as the dynamics at the extensive margin. Our main findings thus apply to both margins.

Tax shocks versus spending shocks. Here, we present results for a specification where we decompose the fiscal shock into government spending shocks and tax shocks, respectively. To

Figure B1: Impulse responses of the female to male employment ratio in different specifications.



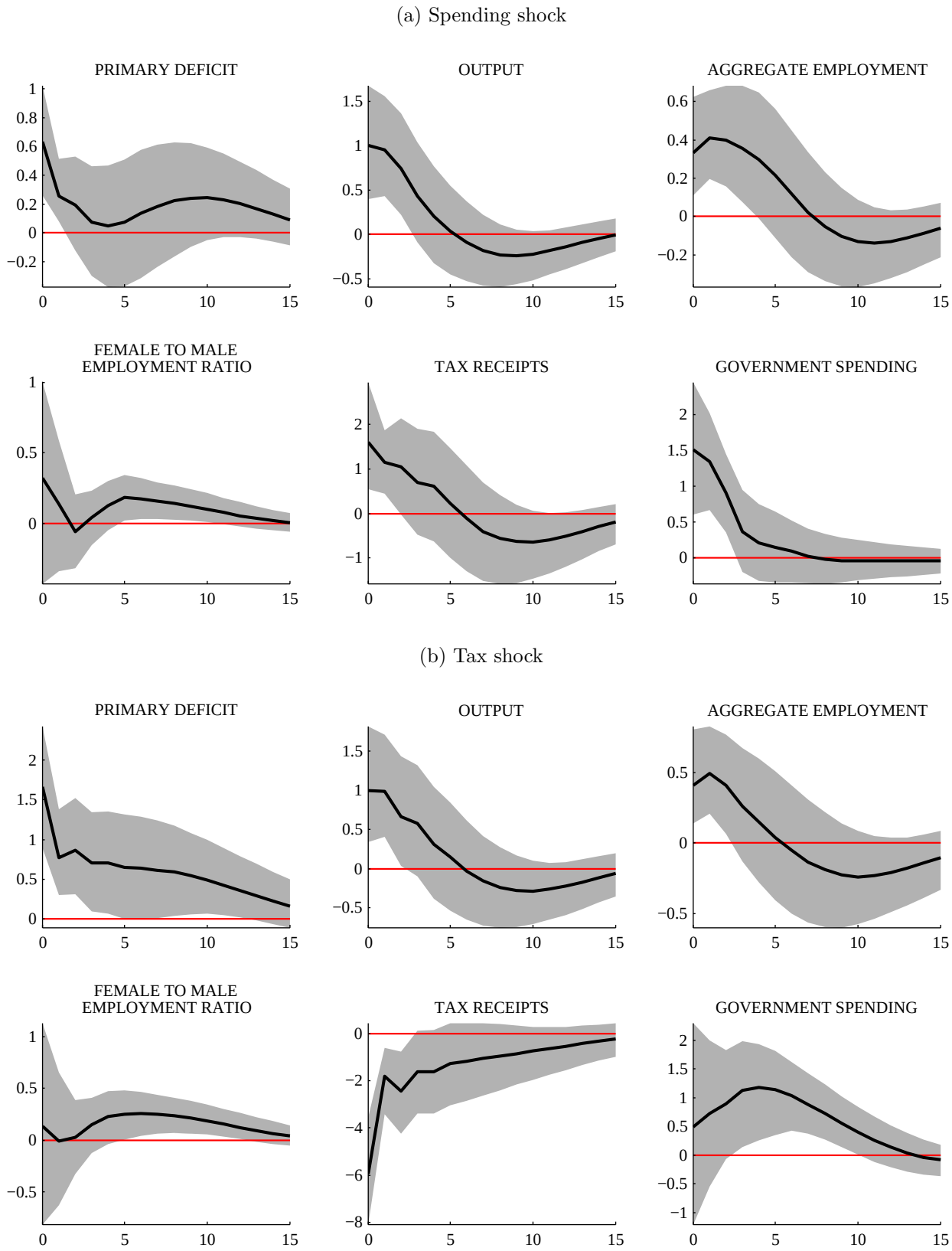
Notes: The solid lines are the median responses and the grey shaded areas show the 16th-84th percentiles of 10,000 estimated responses. The responses are expressed in percentage terms. On the horizontal axes, the horizon is given in quarters. The median impact response of GDP (not shown) is normalized to one percent.

discriminate between government spending shocks and tax shocks, we include tax revenues and government spending as additional variables in the baseline VAR and impose the identifying restrictions discussed in Canova and Pappa (2007). A government spending shock raises spending and tax revenues, whereas an expansionary tax shock reduces tax revenues. In all other respects, the specification is as in the baseline VAR from Section 2. In particular, we impose that both fiscal shocks induce a positive co-movement of GDP and the deficit. Figures B2 (a) and B2 (b) show the responses to a government spending shock and to an expansionary tax shock, respectively. The most important result is that the gender employment ratio increases after both types of fiscal stimuli. The results for the non-fiscal shock are very similar to the baseline VAR, see Figure 1, and are therefore not shown (after a non-fiscal shock, tax receipts increase and government spending does not change significantly).

Pink-collar job booms. We now provide additional evidence for our finding that fiscal expansions lead to pink-collar job booms, complementing our analysis discussed in the main text. First, we show that pink-collar job booms occur also *within* industries. Figure B3 shows the effects of fiscal shocks on the employment ratio between female-dominated industries and other industries (left panel) together with the ratio of pink-collar to blue-collar employment within both female-dominated and other industries (middle and right panels). Within both industry groups, we observe an increase in pink-collar employment relative to blue-collar employment after fiscal expansions.

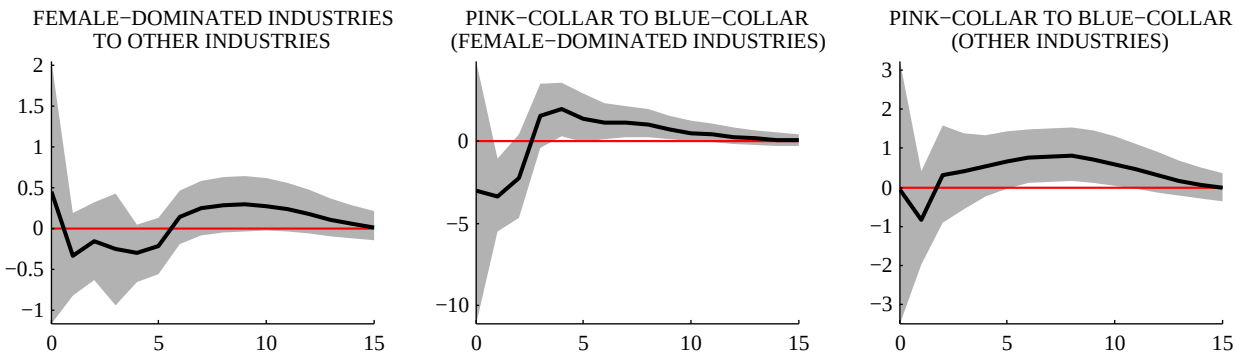
Second, we show that pink-collar job booms are not driven by gender. Figure B4 shows the responses of the female to male employment ratio (left panel) together with the pink-collar to blue-collar employment ratios among women (middle panel) and among men (right panel), respectively. After an expansionary fiscal shock, we find a pink-collar job boom also among male workers.

Figure B2: Impulse responses to tax shocks and spending shocks.



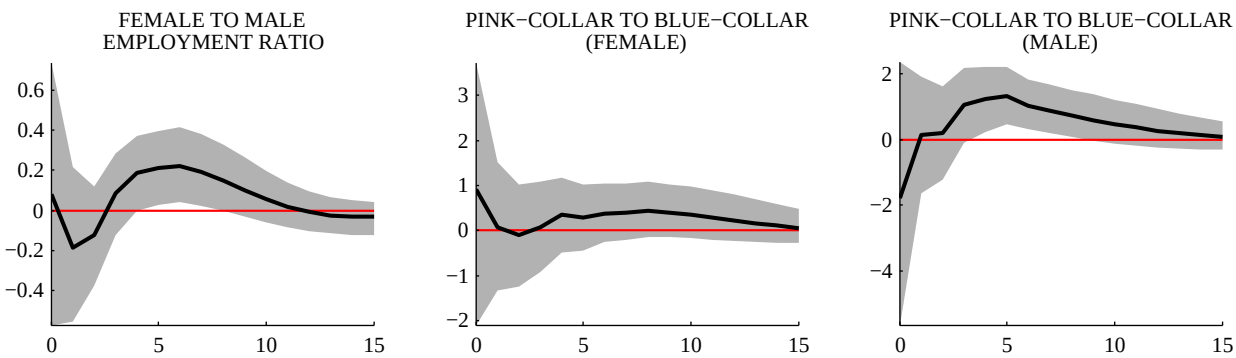
Notes: The solid lines are the median responses and the grey shaded areas show the 16th-84th percentiles of 10,000 estimated responses. The responses are expressed in percentage terms (for the defict, in terms of output). On the horizontal axes, the horizon is given in quarters. The median impact response of GDP (not shown) is normalized to one percent.

Figure B3: Between-industry and within-industry employment dynamics (major occupation groups): Fiscal shock.



Notes: The solid lines are the median responses and the grey shaded areas show the 16th-84th percentiles of 10,000 estimated responses. The responses are expressed in percentage terms. On the horizontal axes, the horizon is given in quarters. The median impact response of GDP (not shown) is normalized to one percent.

Figure B4: Between-gender and within-gender employment dynamics (major occupation groups): Fiscal shock.



Notes: The solid lines are the median responses and the grey shaded areas show the 16th-84th percentiles of 10,000 estimated responses. The responses are expressed in percentage terms. On the horizontal axes, the horizon is given in quarters. The median impact response of GDP (not shown) is normalized to one percent.

C Model appendix

Occupational employment dynamics conditional on gender. In this appendix, we will provide empirical arguments that the decisive characteristics of occupations are not their demographic composition of workers (their different gender shares) but rather their role in the production process (due to differences in tasks and degrees of substitutability across occupations). Put differently, we argue that labor demand rather than labor supply appears responsible for the documented occupational employment dynamics.

Due to well known gender differences in labor-supply elasticities (e.g., Blundell and MaCurdy 1999, Keane 2011), the average worker in a female-dominated occupation can be expected to have a different labor-supply elasticity than the average worker in an other occupation and might adjust his or her labor supply more strongly to cyclical changes in the wage rate. This could explain differences in employment dynamics across occupation groups. However, if the occupational employment dynamics are caused by different labor supply dynamics across genders, we should not observe them in samples which consist of women only or men only, respectively. Yet, there is evidence for pink collar job booms within groups formed by gender. Specifically, Figure B4 shows that significant pink-collar job booms are observed for men. Thus, a theoretical explanation for the documented gender-biased effects of fiscal policy can hardly be based on a pure labor supply argument but, instead, firms' perspective and with it labor demand seems key, as highlighted in our model based on differential substitutability between occupational labor and capital.

Simplified equilibrium conditions. 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:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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. $k_{t+1} = k_t = k$, and hence $\widetilde{k}_t = k \cdot u_t$.

Log-linear equilibrium conditions. In log-linear terms, we obtain the following system where a double dash attached to the equation number indicates the log-linearized version of the respective equation in the main text:

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

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

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

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

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

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

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

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

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

$$\widehat{w}_t^b = \widehat{n}_t^b + \widehat{\tau}_t\,, \tag{18"}$$

$$\widehat{w}_t^p = \widehat{n}_t^p + \widehat{\tau}_t\,, \tag{19"}$$

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

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

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

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

where $\kappa = (\epsilon - 1)/\psi$ is the slope of the linearized Phillips curve, $R_t = 1 + r_t$, and $\widehat{\tau}_t \equiv (\tau_t - \tau)/(1-\tau)$.

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

$$\left(\Delta^{-1} + \frac{2+\phi}{4\phi}\right) \cdot \widehat{u}_t = \widehat{mc}_t + \frac{2+\phi}{4\phi} \cdot \widehat{a}_t + \frac{2-\phi}{4\phi} \cdot \widehat{n}_t^b + \frac{1}{2} \cdot \widehat{n}_t^p - \widehat{\tau}_t, \tag{27}$$

$$\frac{2+5\phi}{4\phi} \cdot \widehat{n}_t^b = \widehat{mc}_t + \frac{2-\phi}{4\phi} \cdot \widehat{u}_t + \frac{5\phi - 2}{4\phi} \cdot \widehat{a}_t + \frac{1}{2} \cdot \widehat{n}_t^p - \widehat{\tau}_t, \tag{28}$$

$$\frac{3}{2} \cdot \widehat{n}_t^p = \widehat{mc}_t + \frac{1}{4} \cdot \left(\widehat{u}_t + \widehat{a}_t + \widehat{n}_t^b\right) + \frac{1}{2} \cdot \widehat{a}_t - \widehat{\tau}_t. \tag{29}$$

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

$$\frac{y}{c} \cdot \widehat{y}_t - \frac{g}{c} \cdot \widehat{g}_t - \frac{\delta_1}{c} \cdot \widehat{u}_t = \Omega^p \cdot \widehat{n}_t^p + \Omega^b \cdot \widehat{n}_t^b - \Gamma \cdot \widehat{mc}_t, \tag{30}$$

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

Together with the linearized production function (1"), (27)-(29) and (30) 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 $\widehat{g}_t = \varepsilon_t^g$, $\widehat{a}_t = \varepsilon_t^a$, and $\widehat{\tau}_t = \varepsilon_t^\tau$ are determined exogenously. Since there is no persistence, there is a static system of linear equations in each period that can be solved for the following equations for output and both types of labor:

$$\widehat{y}_t = \Lambda^{-1}\left(\Delta^{-1} + 3\phi + 5\Delta^{-1}\phi + 7\right)\left(g \cdot \widehat{g}_t - \Gamma \cdot c \cdot \widehat{\tau}_t\right) + \xi_{y,a} \cdot \widehat{a}, \tag{31}$$

$$\widehat{n}_t^b = \Lambda^{-1}\left(8\Delta^{-1}\phi + 8\right)\left(g \cdot \widehat{g}_t - \Gamma \cdot c \cdot \widehat{\tau}_t\right) + \xi_{n,a} \cdot \widehat{a}_t, \tag{32}$$

$$\widehat{n}_t^p = \Lambda^{-1}\left(2\Delta^{-1} + 2\phi + 6\Delta^{-1}\phi + 6\right)\left(g \cdot \widehat{g}_t - \Gamma \cdot c \cdot \widehat{\tau}_t\right) + \xi_{p,a} \cdot \widehat{a}_t, \tag{33}$$

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 additionally subtracting (32) from (33) gives equation (24) in the main text.

In the limiting case where $\kappa \to \infty$, condition (6") implies $\widehat{mc}_t = 0$ such that conditions (1") and (27)-(29) form a system in four equations and four endogenous variables, $\widehat{u}_t$, $\widehat{n}^b_t$, $\widehat{n}^p_t$, and $\widehat{y}_t$ while $\widehat{mc}_t = 0$ and $\widehat{a}_t = \varepsilon^a_t$ is determined exogenously. Solving the static system of linear equations in each period yields equation (25) in the main text and

$$\widehat{n}^b_t = \frac{\phi + 9\Delta^{-1}\phi - 3\Delta^{-1} + 5}{3\Delta^{-1} + \phi + 7\Delta^{-1}\phi + 5} \cdot \widehat{a}_t, \tag{34}$$

$$\widehat{n}^p_t = \frac{\Delta^{-1} + \phi + 5\Delta^{-1}\phi + 5}{3\Delta^{-1} + \phi + 7\Delta^{-1}\phi + 5} \cdot \widehat{a}_t. \tag{35}$$

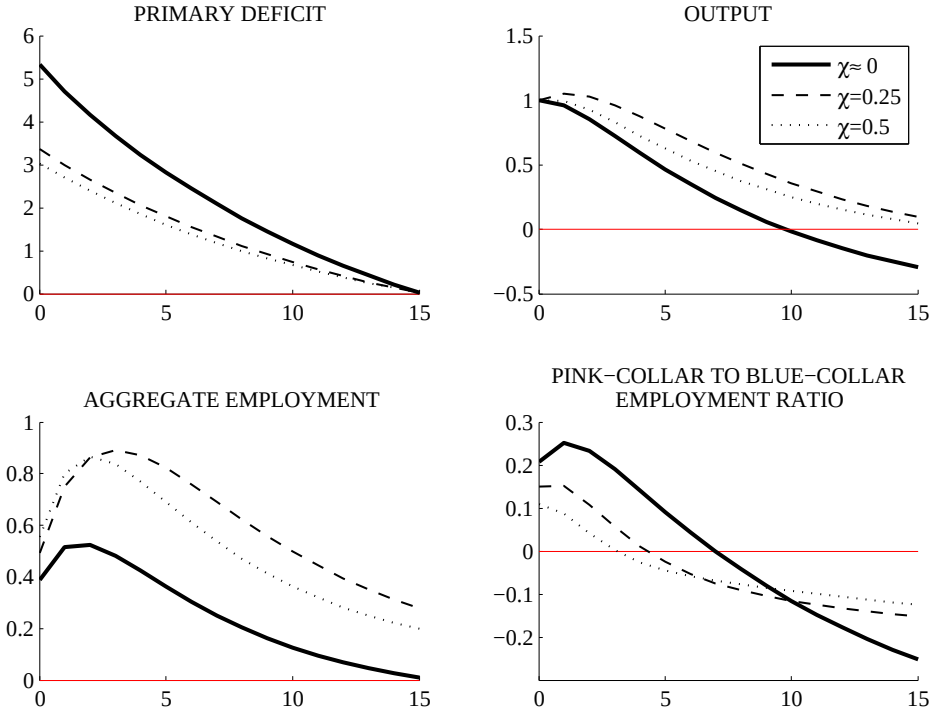
Subtracting (34) from (35) gives equation (26) in the main text.

Sensitivity of model results. Figure C1 displays results for alternative values of the wealth elasticity of labor supply. As discussed in Section 4.5, 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 C1(a). By contrast, a stronger wealth effect magnifies the pink-collar job boom triggered by tax cuts, see Figure C1(b).

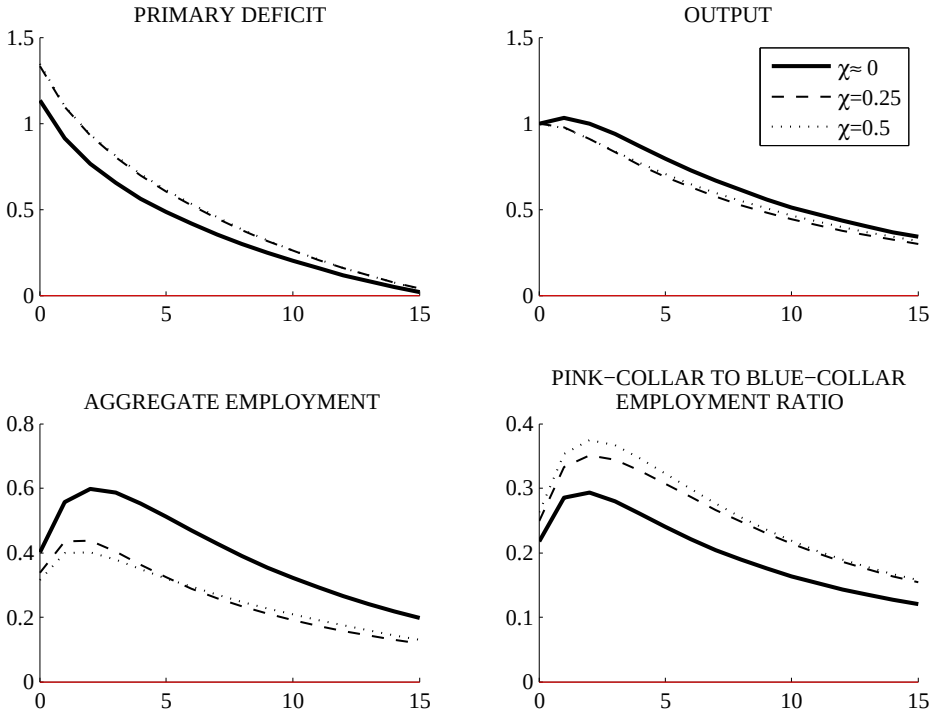
Figure C2 shows impulse responses to an innovation in labor productivity. As for fiscal shocks, we show results for three different parameterizations of the elasticities of substitution in production. In response to an increase in labor productivity a_t, firms substitute away from capital services into 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 blue-collar job boom triggered by a rise in labor productivity.

Figure C1: Impulse responses for different wealth elasticities.

(a) Spending shock

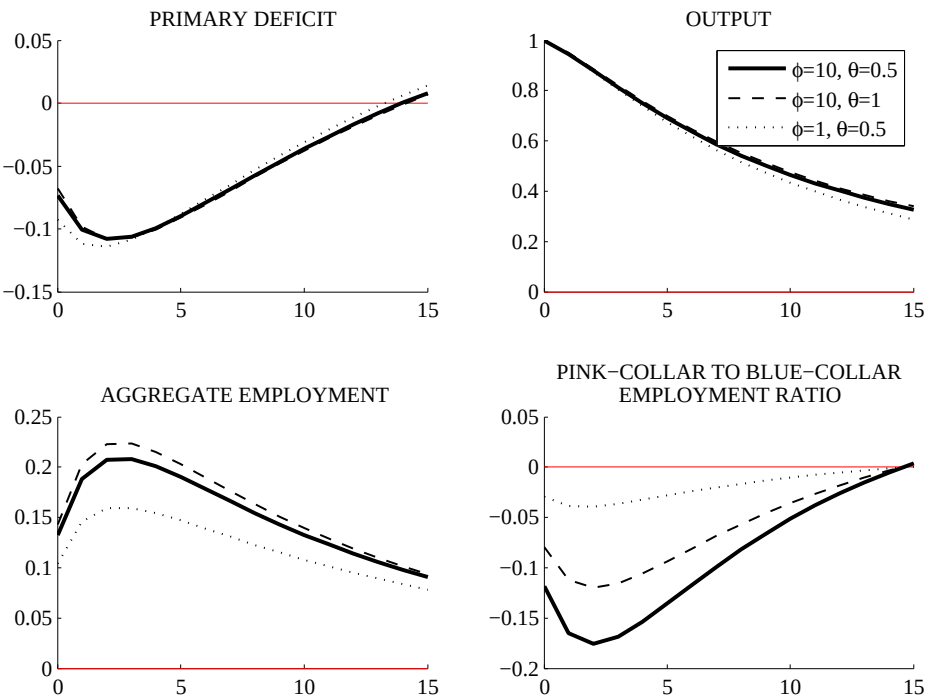


(b) Tax shock



Notes: The responses are expressed in percentage terms. On the horizontal axes, the horizon is given in quarters. Panel (a) shows model-implied impulse responses to a rise in government spending. Panel (b) shows model-implied impulse responses to a cut in income taxes. The size of the innovations are normalized such that the response of output is one percent on impact.

Figure C2: 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 is one percent on impact.