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Productivity in German manufacturing firms: Does fixed-term employment matter?

Sebastian Nielen*and Alexander Schiersch†

Abstract

A growing proportion of employees are working under fixed-term contracts. This paper empirically analyzes whether this strategy actually improves firm productivity. To this end, a large dataset of German manufacturing firms and various panel data models are used in order to reveal the expected non-linear effect. Thereby the analysis also takes into account distortions that may result from selection into the use of fixed-term employment. The results of the investigation show that there is no significant effect of fixed-term employment on labor productivity when controlling for the selection effect.

Keywords: fixed-term employment, labor productivity, manufacturing
JEL-Codes: D24, L23, L60

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1 Introduction

The importance of fixed-term employment in Germany is constantly increasing. The share of fixed-term contracts for new hires increased from around 30 percent in 2000 to about 45 percent in 2010 (IAB, 2011). Although approximately 50 percent of all fixed-term contracts end with transfers into permanent contracts, the proportion of fixed-term workers in Germany is constantly increasing. In 2010 more than 9 percent of all employees required to contribute to social security in Germany are employed under a fixed-term contract. In 2000 this figure was only about 6 percent (Gundert & Hohendanner, 2011). The increasing importance of this type of employment raises the question of whether and how it affects firm performance.

Previous research on temporary work and fixed-term contracts identifies two principle reasons for using this instrument. Firstly, the instrument is used to increase the external flexibility of labor input. Hence, severance payments and the like are not necessary, since expiring contracts simply reduce the number of employees through attrition when demand declines. Second, fixed-term contracts can be used to screen for productive workers. Thus, by selecting the latter and offering them permanent contracts, the overall quality and productivity of the workforce should increase.

However, within the labor market and management literature, the disadvantages of temporary work are also revealed. Here, it is mainly the demotivating effect that temporary work can have on both, temporary and permanent workers, when this instrument is abused. Moreover, the firm specific human capital of temporary workers is lower than that of permanent workers and firms have little incentive to invest in the training of temporary workers.

Since there are opposing effects of temporary work, its overall effect on firm performance is unclear. Previous literature on this topic is rare. Using sector aggregates, Damiani and Pompei (2010) analyzes the effect of labor protection on Total Factor Productivity (TFP) growth in 18 European countries between 1995 and 2005. They also control for the effect of growth in temporary employment on TFP, finding a negative and significant relation. Also using sector data, Auer et al. (2005) analyze the effect of employment tenure on productivity in 13 European countries for the 1992 to 2002 period. Their results show that productivity increases with increasing job tenure, but decreases after thirteen years of job tenure. However, it follows for the case of fixed-term employees, that firms

with a lower share of fixed-term worker should have a higher productivity.

At the micro level, Cappellari et al. (2010) use 13,000 firm level observations of all Italian sectors between 2004 and 2007 in order to analyze the effects of deregulation reforms of apprenticeship and fixed-term contract. They find a small negative, but only weakly significant, effect of the reforms of fixed-term employment on labor productivity and must, therefore, reject their hypothesis that reforms in the legislation of fixed-term increase labor productivity. However, this result is in line with the findings of the two previously mentioned studies. Finally, Kleinknecht et al. (2006) analyze the effect of fixed-term employment using 590 Dutch firm observations. They find no significant effect of the percentage of personnel on fixed-term contracts on sales growth. In order to check the robustness of this finding, they also split the dataset into firms with active R&D and firms without active R&D. Again, in both subgroups no effect of the use of fixed-term employment on sales growth was found. Hence, previous empirical results point toward a weakly negative relationship with the exception of Kleinknecht et al. (2006).

This paper contributes to the literature by analyzing the effect of fixed-term employment on labor productivity for German manufacturing firms. In contrast to the aforementioned studies, we control for the inherent selection problem into using fixed-term contracts by means of the inverse Mills ratio, since some firms systematically do not use this instrument. Additionally, we apply dynamic panel data models to soften the assumption of strict exogeneity of explanatory variables.

The remainder of the paper is organized as follows. The subsequent section discusses related literature and derives the hypothesis. The data are introduced and first descriptive statistics are discussed in section three. The methods used in this study as well as the empirical strategy are introduced in section four along with the empirical analysis. Section five provides a concluding discussion.

2 Theoretical framework

In this section we present theoretical and empirical arguments to explain the relationship between the use of temporary employment and labor productivity. Within the extensive labor market and management literature, we identify three main factors and how they affect labor productivity. The first one is temporary employment as a tool to adjust the employment to product demand fluctuations.

The second one is the screening aspect of temporary employment and the last one argues via firm specific human capital. At the end of this section we discuss how the different aspects might jointly affect labor productivity and derive the hypothesis.

Temporary employment and demand fluctuations

Theory suggests that one of the reasons why firms use temporary employment is because it allows for the adjustment of labor input when product demand fluctuates while avoiding termination costs. One theory, developed by Nunziata and Staffolani (2007), suggests that an increase in the demand for more flexible forms of employment is driven by increasing redundancy costs and volatile product demands. This is in line with the model of Bentolila and Saint-Paul (1992), which suggests that the demand for temporary employment is driven by fluctuations in product demand.

These theoretical considerations are confirmed by the survey of Houseman (2001) on reasons for using temporary employment. In it, the adjustment on demand fluctuations is named as the most important reason for using temporary employment. In the empirical part of the study, Houseman (2001) find a significant relationship between industry seasonality and the probability for using temporary work. Empirical evidence for the adjustment argument is also found by Vidal and Tigges (2009). Moreover, using data of establishments in Germany, Hagen (2003) reports that using fixed-term contracts increases the adjustment speed of work force to changes in product demand. Because of a higher flexibility of using fixed-term contracts as a tool to deal with changes in product demand, temporary work should have a positive effect on labor productivity. However, the effect of this instrument is limited because the termination of fixed-term workers without paying redundancy costs is only possible when the contract ends.

Temporary employment and screening

Another main aspect of fixed-term contracts is the fact that it can be used to screen for new productive workers or to substitute for core workers. According to principal agent theory firms cannot observe the productivity of potential new employees before hiring them. Wang and Weiss (1998) provide a theoretical model in which firms use fixed-term contracts to screen new employees for a

certain period. After the screening period the more productive employees will get open-ended contracts.

Using fixed-term contracts to screen potential new employees increases productivity in two ways. First, during the probation period the employee has an incentive to increase his/her effort in order to get an open-ended contract. This is confirmed by the findings of Engellandt and Riphahn (2005). They find that employees with a fixed-term contract have a higher probability to work unpaid overtime compared to employees with open-ended contracts. Second, offering open-ended contracts only to the most productive fixed-term contract employees will increase the productivity in the long run. Empirical evidence for the screening argument is found by Gerfin et al. (2005) and Addison and Surfield (2009). The results of Picchio (2008) show that, in Italy, employees with a fixed-term contract have a significant higher probability to have an open-ended after two years than unemployed persons.

For Germany, empirical evidence for the screening argument is reported by Boockmann and Hagen (2008). Gash (2008) find empirical evidence for fixed-term contracts to be a bridge to an open-ended contract. Moreover, McGinnity et al. (2005) show that fixed-term contracts are often used as a tool to screen new employees during the transition from education to work for West Germany. Using data from the German Socio-Economic Panel, Mertens and McGinnity (2004) find, that about 40 percent of employees with a fixed-term contract have an open-ended contract one year later. Overall, empirical evidence for the use of temporary work as a sorting mechanism is given for Germany. However, in the case of Spain, where the labor market is highly segmented between temporary and permanent work, there is no evidence for the screening aspect of fixed-term employment (Amuedo-Dorantes, 2000). Thus, the effect also depends on the structure and permeability of the labor market.

As mentioned above, fixed-term employees can also be used to substitute core workforce. Yet, this strategy comes with negative effects, since it could lead to decreased motivation of both, fixed-term and existing core employees (Vidal & Tigges, 2009). Decreasing motivation of employees with fixed-term contracts may result from lower job stability (Bergmann & Mertens, 2011) and lower wages (Mertens et al., 2007) compared to employees with permanent contracts. Lower motivation of core workers could be driven by decreasing trust in commitment of the firm (George, 2003). Less motivation of both types of workers could then result in lower labor productivity (Brown & Sessions, 2005). This effect directly

depends on the share of temporary workers on total work force of a firm. If the share of employees with fixed-term contracts is relatively high, employees fear a replacement strategy instead of screening and motivation may decrease (Cuyper et al., 2008).

Hence, with respect to screening and motivation, the effect of fixed-term workers on productivity depends on their share in total work force. On the one hand, a moderate use of fixed-term contracts should increase labor productivity due to the screening possibility and its positive motivational aspects. On the other hand, an excessive use could negatively affect labor productivity because motivation of both types of workers decreases.

Temporary employment and human capital

A third aspect of fixed-term contracts is the positive link between productivity and firm specific human capital. Investing in firm specific human capital becomes profitable in the long run. Hence, if the contract of employees ends after a relative short period, there is little incentive for firms to invest in the firm specific human capital of these employees. Therefore an increasing share of fixed-term contracts on total work force should go in line with decreasing investments in firm specific human capital. Empirical evidence for a negative relationship between temporary work and investing in human capital is reported by Arulampalam et al. (2004). Also Booth et al. (2002) find that employees with temporary jobs receive less training than employees with open-ended contracts. Moreover, findings of Shire et al. (2009) suggest that firms offering further training tend to make use of long term contracts rather than temporary employment. The same is reported by Albert et al. (2005). They find that firms, that do not provide vocational training, have higher shares of temporary worker compared to firms offering further training. Their results also show that given that a firm provides on the job training, employees with temporary contracts have a lower probability of receiving training compared to the ones with open-ended contracts. Yet, as shown by Zwick (2006) for the German case, on-the-job training enhances firm productivity. Moreover, employees receiving training are also more satisfied with their job and, therefore, have a higher job performance (Jones et al., 2009). Regarding the relationship of fixed-term employment and the incentive to invest in human capital, an increasing share of employees with temporary contracts reduces labor productivity due to lower investments in firm specific human capital.

Temporary employment and labor productivity

Summing up, we find arguments for a positive as well as for a negative relationship between the share of fixed-term workers in a firm and its productivity. First, when using temporary employment as a tool of adjustment on changes in product demand, it should increase labor productivity. However, this strategy is restricted because employees with a fixed-term contract can only be laid off without paying redundancy costs when the contract ends. Second, a moderate use of fixed-term employment to screen for productive employees should increase labor productivity, while an extensive use in order to replace core workers with temporary ones may reduce labor productivity due to the decreased motivation of both types of employees. Third, an increasing share of fixed-term employees should be accompanied with decreasing labor productivity, because the incentive to invest in firm specific human capital is lower compared to permanent employees and human capital and productivity are positively linked.

Combining these arguments, the overall effect of using fixed-term contracts on labor productivity depends on the share of fixed-term contracts on total work force of an establishment: a moderate use of fixed-term contracts should increase labor productivity due to increasing flexibility of labor input and the possibility to screen for productive employees, both overcoming the negative effect of lower firm specific human capital; an intensive use should have a negative effect on labor productivity due to less motivation of both types of employees and lower human capital for employees with a fixed-term contract, both overcompensating the positive effect of a higher flexibility of labor input. Hence, our hypothesis is, that the relationship between the intensity of using fixed-term workers and labor productivity is inverse U-shaped.

3 Data

Sample

The study uses IAB Establishment Panel data for the 2004 to 2009 period. The data are gathered and compiled by the German Federal Employment Agency (*Bundesagentur für Arbeit*). It is an annual survey covering about 16,000 establishments per year and it is aimed to be representative both for average and for longitudinal analysis (Fischer et al., 2009). The questionaire includes questions

about staff development, personnel requirements, sales, investment, exports, as well as R&D, innovation and organizational change (Bellmann et al., 2002). In addition, there are specific questions addressing the different forms of employment used by the firm, such as temporary agency work or fixed-term employment. Altogether, the dataset contains about 320 variables, which, however, are mostly related to labor market issues.

In order to apply this to panel models, some editing of the data is necessary. One significant challenge in using the data is that even within individual surveys, questions focus on different time horizons. For example, questions regarding the output or the business development refer to the past calendar year. In contrast, most of the questions related to the labor input are from the current calendar year. Moreover, while the questions related to the firms output are yearly data, some of the input related questions, including, for example, those regarding temporary agency workers, are observations on June 30th of each year. Hence, during data preparation, we must ensure that data are correctly assigned to the year that they reflect. Further, analysis must adequately address the issues resulting from the combining of date data with annual data.

In order to resolve the time dimension problem, the procedure proposed by the IAB for assembling the waves has been reworked so that the variables of each wave are assigned to the year the information belongs to. Consequently two observations out of subsequent years are needed to create one observation for an establishment. This decreases the number of observations dramatically. Further data cleaning is needed to exclude missing observations. Finally, all observation for non-manufacturing establishments are eliminated as well as all observations before 2004 and after 2008. For the latter there are two reasons: First, including data before 2003 might bias the results due to labor market reforms. Second, with the 2009 wave, we have information regarding output variables for 2008, but not for 2009. The output information are merged with the input data of the wave for 2008 and the remaining information, covering 2009 is incomplete and, therefore, dropped. Furthermore, we only included firms with a minimum of five employees. Overall data preparation reduces the number of observations from nearly 85,000 to 10,946. Finally, all firms with fewer than three observations are excluded in the latter analysis in order to apply panel data models. This reduces the number of observations to 8,821 from 2,244 manufacturing establishments for the 2004 to 2008 period.

Measurement of variables

The dependent variable in the analysis is the log of labor productivity (*Labor-Prod*), which is calculated as real sales per capita. The deflation is done using sectoral producer price indices of the OECD for Germany. The regressor of interest is the log of the share of fixed-term employed on total employees (*Share*). Here, neither the number of temporary agency workers nor interns are taken into account. The reason is that both numbers are asked for as date data. We know, however, that the job duration of fifty percent of all temporary agency workers in client firms is less than 3 month. Interns in Germany work between one and six months. Hence, although we might find temporary agency workers or interns on the 30th of June, it is highly possible that they have not been in the firms in the beginning of a year and that they will not be there through the end of a year. Simply adding them to the number of employees would therefore cause the analysis to be biased. For the so-constructed variable, we expect the coefficients of *Share* to be significantly positive if the theoretical remarks of section two hold true. Moreover, since the effect might be non-linear, the variable is also included in the analysis with its squared values (*Share2*) and the respective coefficient is expected to be negative.

In addition to these regressors, we include the logarithms of the following control variables: the overall number of employees to capture the size of the firms (*Size*); the proportion of intermediate inputs on sales (*Intermediate*) to capture the position of the firms in the value chain; the share of qualified employees on total labor force (*Qualified*) to catch the human capital intensity of production; the share of woman in the company (*Female*) as an additional control variable for the employment structure; the share of exports on sales (*Export*) to take into account the range of business activities of firms; and finally the investments per capita (*Investment*), which captures investments in ICT capital, production equipment, buildings and the like, as proxy for the capital intensity of production.

Additional control variables in the analysis are the following dummy variables: the age of the companies (*Age1-Age5*) for companies younger than five years, five to nine years, ten to fourteen years, fifteen to nineteen years, and twenty or more years; a dummy variable that equals one if a company closed a part of the firm within the last year (*Closed*); a dummy variable if a part of the firm was outsourced (*Outsourced*); if a spin-off has taken place (*Spin*); a dummy variable that becomes one if a part of another company was integrated (*Integrated*);

dummy variables if the majority owner is East German (*Owned1*), West German (*Owned2*), a foreigner (*Owned3*), is the state (*Owned4*), has no majority owner (*Owned5*) or if the majority owner is unknown (*Owned6*); dummy variables for each of the sixteen industries in the analysis; as well as sixteen dummy variables for federal states the establishments are located in; six dummy variables for the legal form of the companies (*LegalForm1-LegalForm6*), which are individual enterprise, partnerships, incorporated, capital companies, corporation and others; dummy variables for companies with sectoral collective agreement, company collective agreement and no collective agreement (*Tarif1-Tarif3*); and a dummy variable taking the value of one if a company has a work council (*WorkConcil*).

[insert Table 1 and Table 2 about here]

Table 1 provides descriptive statistics for all continuous explanatory variables and for the dependent variable labor productivity, distinguishing between within and between variation and Table 2 contains simple descriptive statistics for the dummy variables. For most variables between variation exceeds within variation. Interestingly for *Share* the between variation is only a little higher. Hence, the share of fixed-term employees changes considerably over time and not just between establishments.

[insert Table 3 and Table 4 about here]

Table 3 reveals the regional distribution of observations and Table 4 contains the descriptive statistics of the share of fixed-term employment per industry. From Table 3 it can be seen that 4,398 establishments are located in West Germany, while 4,138 are located in East Germany and Berlin is the location of 285 establishments. The mean share is rather low, ranging from 2 to 5 percent in the entire data set. But among those firms that used fixed-term employment, the mean ranges from 5.5 to 13 percent. Moreover, the maximum share ranges from 26 to almost 100 percent. Thus, fixed-term employment is a significant input factor and is occasionally heavily used. Finally, since some firms have never used this instrument, the analysis is subject to a selection problem.

4 Empirical investigation

The analysis of the relationship between the use of fixed-term contracts and labor productivity is presented in three steps. First is our estimation strategy.

We follow with our main results, and then, some robustness checks are presented.

Methods and empirical strategy

To control for the potential self-selection into the use of fixed-term contracts, the empirical estimation starts with the estimation of a probit selection model. The dependent variable takes the value of one if a company uses fixed-term contracts and zero otherwise. Based on the result of the probit model we calculate the inverse Mills ratio. This ratio is used as an additional variable in the regression models to control for the selection effect. For detailed discussion of this approach see Briggs (2004). To increase identification of the model and to avoid potential multicollinearity between the inverse Mills ratio and the explanatory variables of the regression models we exclude some variables used in the selection model from the regression models in the second stage, as proposed by Puhani (2000).

To test the hypothesis of an inverse U-shaped relationship between the use of fixed-term employment and labor productivity, the following equation is estimated:

$$log(LabProd_{it}) = \beta_1 Share_{it} + \beta_2 Share2_{it} + \gamma_k log(x_{kit}) + \theta_m D_{mit} + \delta Mills_{it} + v_i + u_{it}$$

with $i=1,...,N$, $t=1,...,T$, $Share=log(1+Share)$ and $Share2=0.5*Share^2$. $Share_{it}$ is the quotient of employees with a fixed-term contract and total work force of an establishment. X_{kit} denotes all continuous control variables, D_{mit} indicates all dummy variables and $Mills_{it}$ captures the self-selection into the use of fixed-term employment via inverse Mills ratio. Finally v_i denotes an establishment specific fixed effect and u_{it} is the error term capturing unsystematic influences of labor productivity.

The estimation strategy is as follows: To get a first impression of how the use of fixed-term contracts and labor productivity are related, we start with estimating a simple OLS regression model. In order to exploit the panel structure of the data and to control for correlation between unobserved fixed effects and the explanatory variables, we then apply a fixed effect regression model. Finally we estimate two specifications of a system GMM model to account for dynamic effects and possible endogeneity of explanatory variables resulting from a correlation with past error terms.

To overcome the potential weak instrument problem of the first difference GMM estimator proposed by Arellano and Bond (1991), we apply the system

GMM estimator implemented by Arellano and Bover (1995) and by Blundell and Bond (1998). All system GMM models are estimated by using the package provided by Roodman (2009a). Following Roodman (2009b), we reduce the number of instruments by using the collapse option. In the first specification all explanatory variables are treated to be exogenous. In the second specification, both share variables and the export variable are treated as predetermined. Thus, they are assumed to be potentially correlated with past error terms but not with current ones. The lagged dependent variable is endogenous by the nature of the model and is therefore instrumented with own lags starting with lag order two. For all system GMM specifications p-values of the Hansen test of over-identifying restrictions and p-values of a test for second order autocorrelation of the error terms in differences are reported.

For a first robustness check the fixed effects model and both system GMM specifications are estimated without controlling for the inherent selection into the use of fixed-term contracts. To take into account differences between West and East Germany, we apply separate estimations for both groups. This estimations again cover the fixed effects model and both system GMM specifications.

Estimation results

The analysis starts by calculating the inverse Mills ratio to account for potential self-selection into the use of fixed-term contracts. The corresponding estimation results of the probit model are outlined in column one of Table 5. In accordance with Kleinknecht et al. (2006), we find a positive coefficient for firm size and a negative one for the share of qualified employees.

[insert Table 5 about here]

The actual analysis of the relationship between labor productivity and the share of fixed-term employees in total workforce starts with an OLS model in column two, followed by a fixed effects model in column three of Table 5. In both estimates, we find a positive but insignificant coefficient for the *Share* variable as well as a negative and weakly significant coefficient for the *Share2* variable. Hence, the results rather indicate the existence of a weakly negative relationship between labor productivity and the use of fixed-term employment than the existence of an inverse U-shaped relationship. Column 4 and 5 contain the estimates of the system GMM approaches. In column 4, all regressors are modeled

as exogenous, except the lagged dependent variable, while in the second system GMM model both *Share* and *Share2* variables, as well as export intensity, are assumed to be predetermined. We treat both *Share* and *Share2* variables this way in order to check whether previous results are affected by potential endogeneity. Further, export intensity might also be not strictly exogenous, since it is still debated whether exporting firms are more productive, or if they become more productive by starting to export. In both estimates, however, we find insignificant coefficients for *Share* and *Share2*. This implies, first, that the imposed inverse U-shaped relationship is rejected by both estimations and, second, that the potentially negative but weak relationship, as found in OLS and the fixed effect model, also finds no support. In general, the results of our basic models do not support the hypothesis of an inverse U-shaped relationship between the share of fixed-term employees on total work force and labor productivity.

Because the expected inverse U-shaped relationship between the use of fixed-term employment and labor productivity is not found and some results suggest a weak negative relationship between both, we estimate the same regression models without including the *Share2* variable.

[insert Table 6 about here]

In all models the coefficient of *Share* is negative, but not significant. Thus our results provide no evidence for an inverse U-shaped relationship, nor for a positive or negative relationship. Thus, it follows that the share of employees with fixed-term contracts on total work force of an establishment has no significant impact on labor productivity.

With respect to the remaining control variables, *Size* is found to have negative and positive parameters, depending on the applied empirical method. In contrast, we find that when *Intermediate* is larger there is a positive effect on labor productivity in all estimates. This, however, might only control for the effect that higher turnovers are generated by using more intermediate inputs, which translates into higher productivity here, since labor productivity is defined as sales per capita. Another variable with significant coefficients in all models is *Export*. Hence, firms with a higher share on turnover abroad have a higher productivity. This remains, even if we model export intensity as predetermined. Moreover, an increasing share of *Qualified* does also increase the productivity. Only in the fixed effect model the respective coefficient is not significant. The coefficient of *Female* is negative and significant in all models except the fixed

effects model. Hence, since we find no effect for *Female* in the within estimation, the share of female employees on workforce does not have any effect on labor productivity. The signs and magnitude of the coefficients of all control variables are not or only barely affected whether *Share2* is included or not.

With respect to the selection effect, we find the expected. The coefficient of the inverse Mills ratio is significant in the OLS and the fixed effect approach. Hence, the estimation results are subject to a selection effect. Moreover, the coefficients of the inverse Mills ratio in the System GMM approach are not significant. This is what we expect, since by including the lagged dependent variable in the regression, a part of the distortion resulting from the selection is already captured.

In all system GMM estimations shown in Table 5 and 6, the null hypothesis of the Hansen test of over-identifying can not be rejected at a five percent level. Also the p-value of the test for autocorrelation is above five percent. This implies that, in general, the moment conditions are valid and the error terms are not auto correlated.

Robustness checks

Table 7 contains three robustness checks. In the first part the results without controlling for possible selection into the use of fixed-term employment via inverse Mills ratio are shown. The second and third parts provide separate estimation results for subsamples using only establishments located in West and East Germany. For each robustness check the fixed effects model and both system GMM specifications are estimated with and without *Share2*, the squared term of the share variable. In all models only the coefficients of *Share* and *Share2* as well as the number of observations and diagnostic statistics are reported. Control variables included in our base line models reported in Table 5 and 6 are also included in all models, but the respective coefficients are not reported here.[1]

[insert Table 7 about here]

Ignoring the problem of a potential selection effect leads to the expected inverse U-shaped relationship in the fixed effects model. The coefficient *Share* is positive while the coefficient of *Share2* is negative. Both are significant at

[1] The coefficients are available upon request from the authors.

the five percent level. But, however, in both system GMM models both *Share* and *Share2* have negative, but not significant, coefficients. Therefore, the same models are estimated without including *Share2*. The respective coefficient of *Share* is negative in all three models, but only significant in the first system GMM model, which treats all explanatory variables as exogenous except the lagged dependent variable. It follows that ignoring the selection effect would lead to incorrect conclusions regarding the relationship between productivity and the share of fixed-term workers.

Two further robustness checks are carried out by running separate regression models for West and East Germany. For this robustness check, all establishments located in Berlin are excluded because it is not possible to assign them to either West or East Germany. For each subsample, one fixed effects specification and two system GMM models are estimated with and without *Share2*. All models for both subsamples include the inverse Mills ration to control for selection into the use of fixed-term employment. The results for the West German subsample are reported in the second part of Table 7. In the models with both share variables, only the coefficient for share in the second system GMM model is significant at the ten percent level. The respective sign is negative. Excluding *Share2* results in insignificant coefficients for the *Share* variable in all models. In the third part of Table 7 the results for the East German subsample are provided. Again no evidence for the expected inverse U-shaped relationship or for a negative relationship is found. Including both share variables, all coefficients have the expected sign, but only two coefficients of *Share2* are significant. Excluding *Share2* leads to insignificant coefficients in all models for the East German subsample. So in general the robustness checks confirm our findings that there is no evidence for an inverse U-shaped relationship between the intensity fixed-term contracts are used and labor productivity. Evidence for a negative relationship is also not found.

It follows, that our hypothesis of an inverse U-shaped relationship between the share of employees with a fixed-term contract on total work force of an establishment and labor productivity has no support. This result is robust, regardless the estimation method applied or the subsample examined. Moreover, our results also suggest that there is not even a significant relationship between the use of fixed-term employment and labor productivity. However, the analysis has also shown that the selection effect plays a role and ignoring this can potentially lead to false conclusions.

5 Conclusion

The importance of fixed-term contracts in filling vacancies, but also in terms of their share on total workforce, is increasing. The aim of this study is to analyze whether, and if so, to what extent, this development improves the productivity of companies. Put differently, is it in the companies' interest to use this instrument as intensively as possible because it promises to increases productivity?

In order to address this question, we review previous findings of labor market and management research. It shows that temporary employment, in general, is used for two reasons: to screen for productive employees and to handle demand fluctuations. In this respect, using fixed-term contract should positively affect productivity. The literature also suggests the existence of demotivating effects if fixed-term workers are used excessively, as well as decreasing firm-specific human capital with an increasing share of fixed-term workers. Based on the theoretical considerations and empirical findings on these effects, we derive the hypothesis of an inverse U-shaped relationship between the share of fixed-term workers on total workforce and productivity.

To test this hypothesis, we use a large dataset containing German establishments and apply several panel data models. The inherent selection problem is taken into account via the inverse Mills ratio and the inverse U-shape is modeled by two variables, the share of fixed-term workers and its square. Yet, the empirical analysis provides no support for the hypothesis. Rather, we find mostly negative coefficients for both variables modeling the share of fixed-term workers on total workforce, with the squared variable being weakly significant in a few estimations. It is then tested whether the relationship is not inverse U-shaped but negative. Again, no significant relationship is found, although the coefficients are still negative. Hence, our study reveals that there is no significant relationship between the use of fixed-term employment and labor productivity in the German case. This is in line with the findings of Kleinknecht et al. (2006) for Dutch firms. Since we see mostly negative coefficients, although not significant, it also partly confirms the findings of Cappellari et al. (2010) for Italy, where the relationship is found to be negative.

Yet, the question arises why there is no relationship found when labor- and management literature point to the negative and positive aspects of this instrument. The reason might be that the majority of fixed-term contracts in Germany are longer than one year. Hence, the positive effects of adjusting employment

without redundancy costs still exists since a firm can lay off some of the fixed-term works every month (if hired a year before), but it would still have to pay some redundancy costs if it tries to terminate all of them in the event of demand slump. In this respect fixed-term employment is not as flexible as temporary agency work and, thus, the positive effects of increased flexibility are limited. But also the negative effect of lower firm specific human capital only partly apply with job tenures of one year, since much of this knowledge is transferred in the first few months. Moreover, since 50 percent of fixed-term workers in Germany are offered a permanent contract the screening and motivational aspects may also have only little effects. Overall the positive and negative aspects, discussed in the labor- and management literature only partly apply to fixed-term employment in Germany and, thus, the effects might not be as strong.

However, from a policy perspective, this result remains valid. An increasingly flexible labor market in continental European countries, like Germany, is constantly called for. In order to enhance this flexibility, the use of instruments like fixed-term contracts and temporary agency work was simplified by the government. Although this policy was mainly imposed to reduce unemployment and increase the flexibility of the labor market, positive effects for firms were also expected. The findings of this study show, in line with others, that fixed-term contract do not help firms to increase their productivity. From this perspective, therefore, a further expansion of this form of employment seems to be not necessary.

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Table 1: Descriptive statistics: Continuous variables

Variable		Mean	Std. Dev.	Min	Max		N
LaborProd	overall	151081.1	184353.7	76.90006	2724388	N =	8821
	between		175463.7	7563.579	2220908	n =	2244
	within		44059.42	-460589.9	1190973	T-bar =	3.93093
Size	overall	232.8643	1266.344	5	46140	N =	8821
	between		1461.085	5	45024.67	n =	2244
	within		57.42949	-1492.136	2100.664	T-bar =	3.93093
Share	overall	0.0368188	0.075392	0	0.9931973	N =	8821
	between		0.060969	0	0.6739306	n =	2244
	within		0.0477061	-0.4767121	0.7685261	T-bar =	3.93093
Qualified	overall	0.7053579	0.2323985	0	1	N =	8821
	between		0.2116456	0	1	n =	2244
	within		0.1019511	-0.0225833	1.399197	T-bar =	3.93093
Woman	overall	0.2762162	0.2160087	0	1	N =	8821
	between		0.2120015	0	1	n =	2244
	within		0.0503991	-0.1737838	0.8018603	T-bar =	3.93093
Export	overall	0.1902857	0.2577416	0	1	N =	8821
	between		0.2496643	0	1	n =	2244
	within		0.0688229	-0.3597143	0.9102857	T-bar =	3.93093
Investment	overall	5907.227	14783.66	0	714285.7	N =	8821
	between		12510.8	0	410714.3	n =	2244
	within		10200.61	-297664.2	309478.6	T-bar =	3.93093
Intermediate	overall	52.73359	19.10919	1	100	N =	8821
	between		17.27207	3.8	100	n =	2244
	within		9.052377	5.98359	106.0669	T-bar =	3.93093

Table 2: Descriptive statistics: Dummy variables

Variable	Mean	Std. Dev.	Min	Max	N
Age1	0.0457998	0.2090625	0	1	8821
Age2	0.0887654	0.284421	0	1	8821
Age3	0.1904546	0.392682	0	1	8821
Age4	0.1300306	0.3363562	0	1	8821
Age5	0.5449496	0.4980037	0	1	8821
Closed	0.0124702	0.1109781	0	1	8821
Outsourced	0.0133772	0.11489	0	1	8821
Spin	0.0070287	0.0835468	0	1	8821
Integrated	0.025734	0.1583498	0	1	8821
Owned1	0.2998526	0.4582192	0	1	8821
Owned2	0.5711371	0.4949417	0	1	8821
Owned3	0.0997619	0.2996993	0	1	8821
Owned4	/	/	/	/	/
Owned5	0.0179118	0.1326385	0	1	8821
Owned6	0.0091826	0.0953905	0	1	8821
LegalForm1	0.1616597	0.3681592	0	1	8821
LegalForm2	0.033783	0.1806805	0	1	8821
LegalForm3	0.7594377	0.4274492	0	1	8821
LegalForm4	0.0382043	0.1917	0	1	8821
LegalForm5	/	/	/	/	/
LegalForm6	0.0054416	0.0735701	0	1	8821
East	0.5068586	0.4999813	0	1	8821
Tarif1	0.3739939	0.4838895	0	1	8821
Tarif2	0.0938669	0.29166	0	1	8821
Tarif3	0.5321392	0.4989943	0	1	8821
WorkConcil	0.3998413	0.4898933	0	1	8821

Notes: Due to the private policy rules of the IAB, the descriptive statistics of some variables are not publishable due to the small number of cases in the respective subgroups

Table 3: Descriptive statistics: Federal states

State	N	Percent
Schleswig-Holstein	186	2.11
Hamburg	60	0.68
Lower Saxony	766	8.68
Bremen	198	2.24
North Rhine-Westphalia	845	9.58
Hesse	468	5.31
Baden-Württemberg	785	8.9
Bavaria	606	6.87
Saarland	135	1.53
Rhineland-Palatinate	349	3.96
West	4,398	49.86
Berlin	285	3.23
Brandenburg	595	6.75
Mecklenburg-Western Pomerania	390	4.42
Saxony	1,211	13.73
Saxony-Anhalt	776	8.8
Thuringia	1,166	13.22
East	4,138	46.91
Total	8,821	100

Table 4: Descriptive statistics: Share per industry

	all firms					only firms using fixed-term contracts				
Industry	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max
food/luxury	955	0.0448	0.0996	0.0000	0.9500	439	0.0975	0.1284	0.0034	0.9500
textiles/clothing	273	0.0350	0.0674	0.0000	0.4348	127	0.0753	0.0821	0.0034	0.4348
paper/printing/	453	0.0272	0.0670	0.0000	0.8451	199	0.0619	0.0900	0.0016	0.8451
wood sector	480	0.0300	0.0862	0.0000	0.9756	143	0.1009	0.1338	0.0062	0.9756
chemical/pharmaceutical sector	522	0.0414	0.0700	0.0000	0.6000	309	0.0699	0.0793	0.0022	0.6000
plastics industry	484	0.0464	0.0733	0.0000	0.8667	312	0.0721	0.0805	0.0025	0.8667
glass/stones/ore extraction	485	0.0448	0.0830	0.0000	0.6667	235	0.0924	0.0992	0.0011	0.6667
manufacture of basic metals	649	0.0427	0.0858	0.0000	0.9932	359	0.0772	0.1033	0.0005	0.9932
recycling	93	0.0381	0.0826	0.0000	0.4500	27	0.1313	0.1070	0.0152	0.4500
manufacture of fabricated metal	1203	0.0319	0.0528	0.0000	0.4688	541	0.0710	0.0585	0.0020	0.4688
machinery and equipment	1288	0.0281	0.0457	0.0000	0.4286	696	0.0520	0.0511	0.0009	0.4286
motor vehicles, trailers and semitrailers	366	0.0484	0.0645	0.0000	0.3804	245	0.0724	0.0670	0.0013	0.3804
other vehicle production	148	0.0491	0.1209	0.0000	0.8333	83	0.0876	0.1510	0.0021	0.8333
manufacture of electrical equipment	594	0.0389	0.0710	0.0000	0.5238	306	0.0755	0.0839	0.0025	0.5238
precision and optical equipment	524	0.0207	0.0391	0.0000	0.2642	195	0.0557	0.0466	0.0026	0.2642
furniture, jewelry/toys	304	0.0495	0.1388	0.0000	0.9524	121	0.1243	0.1981	0.0029	0.9524

Table 5: Estimation results with controlling for the selection into fixed-term employment via inverse Mills ratio

Variable	1	2	3	4	5
L1 LaborProd				0.4321***	0.4482***
				(0.0887)	(0.0722)
Share		0.2182	0.2083	0.0027	-0.0044
		(0.1897)	(0.127)	(0.3363)	(0.2686)
Share2		-2.1818**	-1.3218*	-0.8666	-1.2378
		(1.0678)	(0.6896)	(1.0163)	(1.2448)
Size	0.6076***	0.0468***	-0.3484***	0.0292	-0.0058
	(0.0215)	(0.0076)	(0.044)	(0.1216)	(0.0502)
Intermediate	0.1020**	0.4059***	0.0348**	0.2041***	0.2008***
	(0.0404)	(0.0169)	(0.0135)	(0.0263)	(0.0257)
Qualified	-0.3933***	0.4627***	0.0453	0.2546***	0.2588***
	(0.1246)	(0.0538)	(0.038)	(0.0798)	(0.0632)
Female	0.2093	-0.9952***	-0.0400	-0.5732***	-0.5549***
	(0.1349)	(0.0554)	(0.0823)	(0.1231)	(0.0894)
Export	0.3215***	0.5122***	0.2853***	0.3528***	0.4402***
	(0.1027)	(0.044)	(0.0643)	(0.106)	(0.1464)
Investment	0.0201***	0.0219***	0.0044***	0.0068	0.0089**
	(0.0049)	(0.002)	(0.0012)	(0.0088)	(0.004)
Closed		-0.1304**	0.0251	0.0348	0.0471
		(0.0532)	(0.0291)	(0.054)	(0.0413)
Outsourced		0.0452	-0.0309	0.0356	0.0344
		(0.0602)	(0.0312)	(0.0472)	(0.0431)
Spin		0.0808	0.0762**	0.1026*	0.0992
		(0.0764)	(0.0326)	(0.062)	(0.0629)
Integrated		0.0529	0.0065	-0.0469	-0.0489
		(0.0405)	(0.0209)	(0.0325)	(0.0321)
Mills		0.0979***	0.4056***	0.0544	0.3692
		(0.0241)	(0.0918)	(1.2618)	(0.496)
Age Dummies	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes
Federal State Dummies	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes
Legal Status Dummies	Yes	Yes	Yes	Yes	Yes
Ownership Dummies	Yes	Yes	Yes	Yes	Yes
Collective Agreement	Yes	No	No	No	No
Work Council	Yes	Yes	Yes	Yes	Yes
Constant	-2.849***	8.8645***	11.8994***	5.1643*	4.4982***
	(0.2378)	(0.1055)	(0.3359)	(2.7049)	(1.093)
No. of observations	8821	8821	8821	6224	6224
No. ID			2244	2124	2124
(Pseudo) R-squared	0.3211	0.5164	0.1276		
Wald chi2	2538.34			8146.84	7219.44
No. of instruments				65	77
Hansen test p-value				0.292	0.096
AR(2) test p-value				0.766	0.829

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
Columns: (1): Probit; (2): OLS; (3): FE; (4): SysGMM exogen; (5): SysGMM predet.

Table 6: Estimation results with controlling for the selection into fixed-term employment via inverse Mills ratio

Variable	1	2	3	4
L1 LaborProd			0.4356***	0.4467***
			(0.0890)	(0.0723)
Share	-0.1407	-0.0202	-0.1335	-0.2292
	(0.1153)	(0.0729)	(0.1984)	(0.1712)
Size	0.0483***	-0.3450***	0.0254	-0.0034
	(0.0076)	(0.0440)	(0.1231)	(0.0526)
Intermediate	0.4061***	0.0355***	0.2036***	0.2013***
	(0.0169)	(0.0136)	(0.0262)	(0.0258)
Qualified	0.4628***	0.0460	0.2544***	0.2565***
	(0.0539)	(0.0378)	(0.0791)	(0.0632)
Female	-0.9974***	-0.0442	-0.5694***	-0.5570***
	(0.0553)	(0.0823)	(0.1235)	(0.0897)
Export	0.5131***	0.2843***	0.3489***	0.4378***
	(0.0440)	(0.0643)	(0.1068)	(0.1465)
Investment	0.0221***	0.0045***	0.0072	0.0089**
	(0.0020)	(0.0012)	(0.0090)	(0.0041)
Closed	-0.1327**	0.0227	0.0357	0.0462
	(0.0533)	(0.0294)	(0.0541)	(0.0416)
Outsourced	0.0458	-0.0290	0.0357	0.0348
	(0.0603)	(0.0313)	(0.0470)	(0.0432)
Spin	0.0805	0.0765**	0.1025*	0.0991
	(0.0766)	(0.0326)	(0.0622)	(0.0627)
Integrated	0.0522	0.0064	-0.0468	-0.0479
	(0.0405)	(0.0209)	(0.0324)	(0.0320)
Mills	0.0965***	0.4126***	0.0994	0.3586
	(0.0241)	(0.0920)	(1.2827)	(0.5200)
Age Dummies	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes
Federal State Dummies	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes
Legal Status Dummies	Yes	Yes	Yes	Yes
Ownership Dummies	Yes	Yes	Yes	Yes
Work Council	Yes	Yes	Yes	Yes
Constant	8.8609***	11.8656***	5.0513*	4.5266***
	(0.1057)	(0.3366)	(2.7497)	(1.1371)
No. of observations	8821	8821	6224	6224
No. ID		2244	2124	2124
(Pseudo) R-squared	0.5161	0.1267		
Wald chi2			8131.38	7227.44
No. of instruments			64	72
Hansen test p-value			0.296	0.070
AR(2) test p-value			0.779	0.838

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
Columns: (1): OLS; (2): FE; (3): SysGMM exogen; (4): SysGMM predet.

Table 7: Robustness checks

	Share	Share2	N	R-squared/ Wald chi2	No. of Inst.	Hansen test p-value	AR(2) test p-value
Without controlling for potential selection into the use of fixed-term contracts							
FE	0.2707**	-1.5777**	8821	0.1175			
	(0.1256)	(0.6857)					
GMM_a	-0.0102	-0.8360	6224	8109.55	65	0.435	0.757
	(0.1425)	(0.6879)					
GMM_b	-0.0401	-1.1476	6224	7959.76	77	0.058	0.752
	(0.2558)	(1.2580)					
FE	-0.0017		8821	0.1161			
	(0.0734)						
GMM_a	-0.1478*		6224	8113.56	64	0.435	0.761
	(0.0756)						
GMM_b	-0.2503		6224	7903.26	72	0.048	0.764
	(0.1702)						
Only establishments located in West Germany (with selection control)							
FE	0.1505	-0.5887	4398	0.1833			
	(0.1402)	(0.6126)					
GMM_a	-0.8429	1.5623	3054	2759.79	59	0.863	0.039
	(1.0447)	(3.5219)					
GMM_b	-0.5958*	2.4841	3054	12039.14	71	0.627	0.037
	(0.3325)	(2.1071)					
FE	0.0613		4398	0.1832			
	(0.0811)						
GMM_a	-0.6111		3054	2680.81	58	0.863	0.031
	(0.5445)						
GMM_b	-0.2114		3054	10760.45	66	0.699	0.036
	(0.2672)						
Only establishments located in East Germany (with selection control)							
FE	0.2228	-1.6503*	4138	0.1269			
	(0.1735)	(0.8669)					
GMM_a	0.2670	-1.3399	2972	2803.07	54	0.216	0.664
	(0.3740)	(1.3700)					
GMM_b	0.4523	-2.9330*	2972	2650.22	66	0.111	0.721
	(0.4537)	(1.5978)					
FE	-0.0858		4138	0.1253			
	(0.0979)						
GMM_a	0.0242		2972	2797.44	53	0.190	0.667
	(0.1817)						
GMM_b	-0.1683		2972	2866.52	61	0.062	0.738
	(0.2237)						

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
GMM_a: System GMM exogenous; GMM_b: System GMM predetermined