Centre for Economic Performance

Discussion Paper

ISSN 2042-2695

No. 2014
July 2024

The wage of temporary agency workers

Antonin Bergeaud
Pierre Cahuc
Clément Malgouyres
Sara Signorelli
Thomas Zuber

The London School of Economics and Political Science

Economic and Social Research Council

Abstract
Using French administrative data, we estimate the wage gap distribution between in-house and temporary agency workers working in the same establishment and the same occupation. The average wage gap is about 3%, but the gap is negative in more than 25% of establishment × occupation cells. We develop and estimate a search and matching model which shows that while the wage gap is largely inefficient, eliminating it reduces efficiency, as it also arises from objective factors that contribute to the efficient allocation of jobs.

Key words: wage gap, temporary work agency, labor market frictions
JEL: J24; J31; J64; J65

This paper was produced as part of the Centre's Labour Markets Programme. The Centre for Economic Performance is financed by the Economic and Social Research Council.

We thank Isaiah Andrews, Stéphane Bonhomme, Philippe Choné, Simon Jäger, Moritz Kuhn, Pat Kline, Thomas Le Barbanchon, Fabien Postel-Vinay, Roland Rathelot, as well as seminar participants at IAB firm and worker quality conference, IZA-Crest 2023, AFSE 2023, Mannheim, Leicester SaM workshop, 25th Anniversary IZA Conference in Labor Economics. We thank the CASD for secured data access (ANR-10-EQPX-17).

Antonin Bergeaud, HEC Paris, CEPR and Centre for Economic Performance at London School of Economics. Pierre Cahuc, Sciences Po, IZA and CEPR. Clément Malgouyres, CREST and IPP. Sara Signorelli, CREST, Ecole Polytechnique and IZA. Thomas Zuber, Banque de France.

Published by
Centre for Economic Performance
London School of Economic and Political Science
Houghton Street
London WC2A 2AE

1 Introduction

Temporary Work Agencies (TWAs) serve as intermediaries between job seekers looking for temporary or flexible work arrangements and employers requiring temporary staff to fill gaps, manage workload peaks, or cover for absent employees (Jahn and Weber, 2016). They allow firms to hedge against short-term fluctuations in a regulated labor market, thereby reducing the duration of vacancies by reducing search frictions. However, TWAs are also often criticized for trapping workers into low-paid jobs (Carrasco et al. 2024), thereby increasing inequalities between in-house and temp workers. The rapid expansion of temporary work agency contracts in many OECD countries in recent years raises important concerns about their aggregate impact on the labor market and on wage inequalities. In this paper, we address these concerns by utilizing novel administrative data that provide detailed information on TWAs and user firms. We then develop and calibrate a model where TWAs act as intermediaries in the market for short-term workers to analyze their overall impact on wages, employment, unemployment, and welfare.

First, we document new empirical facts about the wages of in-house and temporary workers across different firms and markets. We start by following closely the approach taken by Drenik et al. (2020), which extends the model of Abowd et al. (1999) by interacting the firm fixed effects with the workers' contract, distinguishing between in-house and TWA arrangements. However, going beyond the average wage gap, we also highlight the substantial heterogeneity that persists across firms and markets, even after controlling for a rich set of observable and unobservable characteristics of workers and jobs. Our findings indicate that, although there is, on average, a 3% higher salary for in-house workers compared to similar temp workers, this wage gap varies significantly. In fact, the standard deviation is 4 to 5 times larger than the mean, and in more than one fourth of the cases, the gap becomes negative.[1] Finally, we show that the level of wage gap is highly correlated to both using firm and TWA characteristics such as size, revenues per worker and ability to fill vacancies, suggesting that the variation captured by our empirical analysis is not driven by noise but rather by fundamental features of the labor markets.

[1]Directive 2008/104/EC of the European Parliament and of the Council of 19 November 2008 on temporary agency work states that the principle of equal treatment of temporary and in-house workers applies to basic working and employment conditions, including the duration of working time, overtime, breaks, rest periods, night work, holidays, public holidays, and pay. However, empirical studies recurrently find a wage penalty for TWA workers, suggesting that this regulation is only indicative and not truly enforced.

To better understand the source of this heterogeneity and its link with the functioning of the labor market, we develop and quantify a directed search and matching model[2] in which firms may opt to use TWAs for two primary reasons: to speed up the hiring process and to reduce human resources (HR) management costs. The model allows us to derive a simple formula for the wage gap, resulting in part from the externalization of vacancy costs by user firms, which reduces welfare –as measured by production net of vacancy and capital costs. We refer to this channel as the "inefficient" portion of the wage gap. A second part of the wage gap, however, arises from differences in HR management costs between user firms and TWAs, which contributes to the efficient allocation of labor.

More precisely, in our model, when hiring directly, the cost of vacancy maintenance (associated with the user cost of capital) does not directly affect the wages of in-house employees because the employment contracts start after the match is realized. In the absence of TWA, the ability of workers to direct their search toward in-house versus temp jobs implies that the equilibrium is efficient (Acemoglu and Shimer, 1999). In contrast, in the presence of TWA, the contract between TWAs and user firms is established at the beginning of the search process and the maintenance cost is not yet paid when the price paid by the user firm to the TWA is determined. Accordingly, the costs of vacancy maintenance are partially passed onto the TWA through lower prices, which in turn depresses wages paid to temp workers. This pecuniary externality is not internalized by user firms and they will tend to resort more to TWA than what is socially optimal. On the other hand, the TWA's markdown on wages induces job seekers to direct too much of their search towards in-house positions rather than temp jobs.

To empirically evaluate the inefficiency associated with the TWA's markdown, we use our data to quantify the model by considering cells of commuting zones (Zones d'emploi or CZ) and occupations, and by combining various administrative datasets. We consider the average wage gap between in-house and temp workers in short-term contracts, their job finding and filling rates, and the average job duration. From these values, we solve the model recursively and estimate market-specific parameters,

[2]The decision to use a directed search model, rather than a random search model, is grounded in both theoretical and empirical considerations. From a theoretical standpoint, markets with directed search operate under a constrained efficient decentralized equilibrium (Moen, 1997; Wright et al., 2021). This approach enables us to clearly identify potential inefficiencies linked to the activity of TWAs. From an empirical perspective, job seekers can easily search for vacancies posted by TWAs or other firms, especially since the internet has become a critical job search channel (Kircher, 2022).

allowing us to decompose the sources of the wage gap and evaluate the portion associated with the inefficient use of temp workers across 649 local labor markets. In these markets, the share of TWA markdown in the wages of temp workers varies from about 1% to 16%, with an average of 6.4%.

We show that it is theoretically possible to eliminate the inefficient portion with wage subsidies paid to temporary workers, financed by taxes on temporary job vacancies. Such a policy would lead to an optimal allocation of workers, matching the welfare level of the constrained optimal equilibrium. However, in practice, such subsidies and taxes may be difficult to implement due to the heterogeneity of local labor markets and their definition based on imperfectly observed parameters. Accordingly, we explore the consequences of a more realistic policy aiming at eliminating the wage gap entirely, not just its inefficient component.[3]

Our findings reveal heterogeneous effects on welfare across local labor markets, which can be positive or negative. This ambiguous effect arises from the fact that the wage gap is the result of objective factors that contribute to an efficient allocation of jobs. Quantitatively, we estimate that a policy eliminating the wage gap would slightly reduce aggregate welfare by 0.3% and have a negative impact on employment in all local labor markets, leading to an aggregate employment loss of 6.2%. This result underlines the subtle effect of TWAs on the efficiency of the labor market: even if they can create a significant wage differential across observationally similar workers, their higher relative efficiency in matching workers to vacancies has an overall positive impact on welfare. Consequently, we find that banning all TWAs from labor markets will lead to a reduction of total welfare by 1.4% and of employment by 6.4%.[4]

Related literature: This paper is mainly related to two strands of the literature.

A first strand analyzes the consequences of domestic outsourcing (as distinct from international outsourcing or offshoring) on wages. Several contributions analyze situations in which contracting firms provide goods and services that are not produced by

[3] Another theoretical solution is to merge the TWAs with the user firms to avoid the externalization of vacancies maintenance costs of user firms, as shown in appendix B.5.

[4] Our model only focuses on short-term contract workers and does not take into account the dynamic impact of TWAs on facilitating the transition of these workers into permanent positions. Table A.3.1 in Appendix shows that the transition rate from TWA contracts to permanent contracts amounts to 3% and that the transition rate from in-house temporary contracts to permanent contrats equals 4%. This is consistent with recent evidence from Spanish data (Carrasco et al., 2024) which suggests that the effects of TWAs on improving the insertion into more stable and permanent employment are limited. Specifically, while TWAs can provide immediate employment opportunities, their role in leading to long-term stable employment is mitigated, indicating that temporary agency work does not significantly enhance the likelihood of obtaining permanent positions.

in-house workers (food, security, cleaning or general administrative services). Goldschmidt and Schmieder (2017) find that workers outsourced to service providers experience a decline in wages that is almost entirely explained by a decline in firm-specific wage premia, as captured by AKM fixed-effects. Bilal and Lhuillier (2021) combine an empirical investigation of the productivity and wage effect of exogenous shift in outsourcing with a frictional labor market model in order to gauge the aggregate effects of domestic outsourcing. We depart from these papers by focusing on another type of outsourcing for which the contracting firms, namely the TWAs, provide the same types of labor services as those of in-house workers.[5] Autor (2001) shows that TWAs can be seen as a screening device for user firms. A similar role is described by Beneito et al. (2024). Both Neugart and Storrie (2006) and Autor and Houseman (2010) assess the role of TWAs as a stepping stone toward more stable employment in user firms. Closer to our paper, Drenik et al. (2020) use data from Argentina to show that temp workers receive lower wages than in-house workers, even when working within the same user firms. Building on this research, we expand their findings using newly available data from France to confirm their main results about the average wage gap. This approach further enables us to document the large dispersion of the in-house to temp workers' wage gap across firms and markets and to describe the features to which these wage gaps are correlated. Finally, we contribute by developing a simple model of TWAs in a frictional labor market that give rise to differential wage policies between temp and in-house workers. This model allows us to understand and evaluate both the causes and the welfare implications of these discrepancies.

The second strand of the literature is related to the role of intermediaries in markets with frictions. The seminal paper of Rubinstein and Wolinsky (1987) shows that the impact of intermediaries on the distribution of gains from trade and on market efficiency depends on the characteristics of the market. In line with this seminal paper, there is a significant body of literature that analyzes the role of intermediaries in markets with frictions, with applications for financial markets and product markets – see e.g. Biglaiser and Li (2018); Gautier et al. (2023); Masters (2007); Watanabe (2020); Weill (2020). This literature confirms the results of Rubinstein and Wolinsky (1987): the impact of intermediaries on the distribution of trade gains and on efficiency depends on the context of each market. In many cases, intermediaries deteriorate efficiency. Yavaş

[5]The contract between the user firms and the service providers in the cited papers focuses on the output (for instance a cleaning, security, or logistic service), while in our case it focuses on the hours of work provided by the temp worker.

(1994) analyzes a labor market where an intermediary is a platform that matches the employers and the employees and does not trade on its own account. He finds that this type of intermediary can have a negative impact on efficiency. Our contribution is to study the properties of a model that specifically represents the role of TWAs in a labor market with frictions. We show that, starting from an efficient directed-search benchmark (Moen, 1997; Acemoglu and Shimer, 1999), the introduction of TWAs with potentially superior search and contract management technologies can lead to an inefficienct allocation so that the net effect of TWAs on welfare is theoretically ambiguous. We explain the wage gap distribution and its relation with the inefficiency of the decentralized equilibrium. We find that TWAs improve the functioning of the labor market in our empirical context insofar as their presence enhances welfare, but their downward pressure on wages constitutes a source of inefficiency. Furthermore, we assess the consequences of different public policies aimed at limiting this inefficiency.

The rest of the paper is organized as follows. Section 2 provides some descriptive statistics about TWAs in France and the characteristics of firms that use this type of contracts, and describes the data used in the main analysis. Section 3 analyzes the magnitude of the wage gap empirically, and shows how it correlates with firm and market characteristics. Section 4 presents our theory and Section 5 our quantitative analysis. Section 6 concludes.

2 Institutions and Data

2.1 Temp Workers in France

Temp workers are formally employed by a temporary work agency but they work for another company. In France, TWAs can only hire workers on fixed-term contracts.[6] Workers can also be employed in-house under fixed-term contracts known as CDDs (*"Contrat à Durée Déterminée"*). The regulations governing fixed-term contracts are identical, whether they pertain to temp workers from a TWA or in-house employees under a CDD. The only difference between CDDs and TWA contracts is that, for the CDD, the employer is the company where the employee works, whereas for the TWA contract, the employer is the TWA itself. However, the labor law states that temp

[6]Since 2018, a law allows TWAs to hire workers on open-ended contracts known as *"CDI intérimaire"*. However, this possibility remains rarely utilized (only 0.3% of the TWA job offers in 2019 are open-ended), primarily for high-skill profiles.

workers act under the authority of the employer of the user company and that the temp workers' salary must adhere to the same compensation rules as those applicable to the employees of the user company (notably in terms of sectoral minimum wages). Specific rules define the conditions under which someone can be hired on a fixed-term contract, primarily: i) to address a temporary surge in activity, ii) to replace an employee on leave, and iii) for roles inherently temporary in nature. Moreover, fixed-term contracts can be renewed up to two times, with the combined duration not exceeding 18 months.

France's labor market is relatively polarized, with 85% of employees working under protected open-ended contracts (*"Contrat à Durée Indéterminée"*, or CDI) while the remaining 15% are in fixed-term contracts, which are primarily taken up by young and low-skilled workers. Hence, while the overall incidence of TWA employment, equal to 6% in 2019, might appear small, it accounts for a much larger share of employment in the low skill segment, and an even larger portion of job vacancies and of flows in and out of employment, rendering TWA a key element for understanding employment dynamics. Among all new contracts signed in 2019 in the private sector, 50% where TWA contracts.[7] Moreover, the share of temp workers in the private business sector over total employment follows a positive trend. It has gone from 4% to 6% of employees between 2009 and 2019 and TWA are becoming an increasingly popular form of fixed-term contracts, reaching roughly 54% of all fixed-term contracts by 2019, from only 40% in 2009.[8] Interestingly, this trend is due to CDD contracts being substituted for TWA contracts, as the share of fixed-term contracts among all in-house contracts has remained constant over time (if anything it is slightly decreasing since 2016). Appendix Figure A.1.2 shows that, while low paying occupations count a larger share of TWA workers relative to high paying ones, TWA employment constitutes a non-negligible share of the occupational labor force up until the 7th percentile of the occupational wage distribution, indicating that this type of contract is used widely across many different types of jobs.

Table I reports the occupations that make the largest use of temp workers. In the list we find occupations in the care sector, such as caregivers, nurses and midwives, and

[7] Authors calculations based on the MMO database.

[8] According to the 2021 OECD Employment Outlook (OECD, 2021), TWA employment is becoming increasingly prevalent in most OECD countries. In 2019, France had the 5^{th} largest share of temporary agency employment within its labor force, ranking behind only Spain, the Netherlands, Slovenia, and Slovakia. The rapid growth of staffing has also been documented in the USA (Atencio-De-Leon et al., 2024).

unskilled blue collar professions in construction, industry and maintenance. These sectors have a high proportion of fixed-term contracts, including CDDs and TWA contracts. The table further reports the unconditional relative wage gap between temp workers and in-house workers, showing substantial differences across categories.

TABLE I. Occupation with the highest shares of temporary agency workers

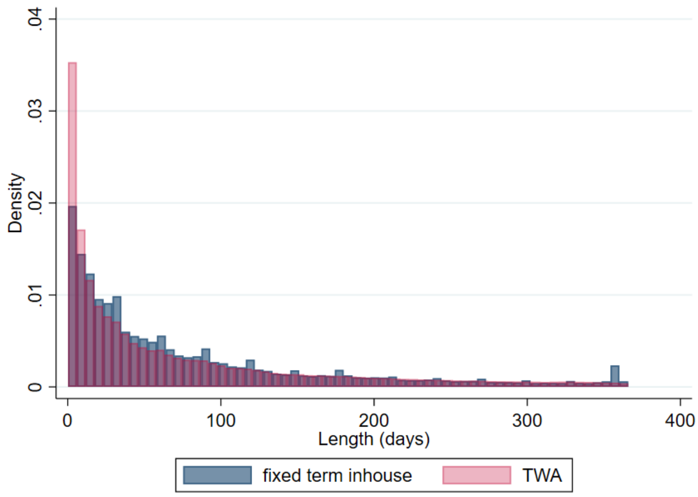
Occupation		Share of TWA		Relative wage gap	
Code	Description	All workers	Fixed-term workers	All workers	Fixed-term workers
V0Z	Caregivers	0.43	0.89	-0.07	-0.08
J0Z	Unskilled BC workers in maintenance	0.40	0.85	0.08	0.002
E0Z	Unskilled BC workers in process industries	0.40	0.87	0.07	-0.04
C1Z	Skilled BC workers in electrical and electronic industries	0.36	0.92	0.23	0.06
V1Z	Nurses, midwives	0.35	0.92	0.13	-0.02
V4Z	Social workers	0.31	0.89	0.25	0.02
A2Z	Agricultural technicians and managers	0.29	0.91	0.30	0.10
B0Z	Unskilled BC workers in construction	0.26	0.66	-0.01	-0.06
D0Z	Unskilled BC workers in metal industries	0.25	0.86	0.06	-0.10
B5Z	Machine operators in construction	0.16	0.88	0.12	-0.01

Notes: Shares are calculated by taking the ratio of the total hours worked by TWA ("interim") workers over total hours by all workers. The relative wage gap is computed as the average in-house wage minus the average TWA wage, divided by the average in-house wage. It can be thus interpreted as a % difference in favor of in-house workers. Only private sector. Period: average over 2017-2019. Source: DADS.

Figure I shows the distribution of the length of all fixed-term contracts signed in 2019 in the private sector, distinguishing between in-house contracts (CDD) and TWA contracts. It is constructed using the payroll tax data *DADS poste*, which we use for most of the analysis in this paper. One caveat is that this data aggregates all contracts signed within the same TWA in a given year into one single spell (see Section 2.2 for more details). For this reason, in Appendix Figure A.1.1 we also show the distribution of contract length obtained from a different data source that allows us to disentangle the length of each single contract within a repeated spell. The median (mean) length of in-house fixed-term contracts in the DADS data is 46 days (81 days), while for TWA contracts it is 34 days (72 days). While being statistically different from each other, it seems clear that these two types of contracts are used by firms for similar types of missions and thus can be seen as rather substitutes. It is also important to notice that most of these spells are combinations of shorter contracts that are rolled-over several times, as shown by Figure A.1.1 in appendix.

Finally, contrary to other forms of externalisation such as outsourcing, the relation between user firms and TWAs takes place predominantly at the local labor market level. In fact, for 75% of TWA contracts, the establishment using the worker is located within 20.6 kilometers from the TWA, and only 29% of contracts take place between

FIGURE I. Distribution of contract length



Notes: The graph is constructed using the *DADS data*, which aggregates all contracts signed within the same TWA in a given year into one single spell. It shows the distribution of the length of all fixed-term contracts signed in 2019, expressed in full time equivalents, and disentangles between in-house (CDD) and TWA contracts.

a user firm and a TWA located in different commuting zone (*"Zone d'emploi"* or CZ).[9] This motivates our choice to consider a labor market as a pair of CZ and occupation. Appendix section A.1 reports additional descriptive evidence of the distribution of TWA contracts across geographic areas.

2.2 Data

We rely on the administrative payroll database (the *DADS*) to recover the wage gap between in-house and temp workers. In particular, we apply the extension of the Abowd et al. (1999) (AKM) model put forward by Drenik et al. (2020), controlling for differences in user firm characteristics, individual characteristics, and other observable components such as occupations and commuting zones. To apply this methodology, we exploit two important features of the French administrative data. First, we use the fact that, since 2017, the data reports the user firm identifier for all TWA workers to compare them with in-house workers employed by the same firm.[10] This

[9]The commuting zones are purely statistical entities defined by the French statistics office -INSEE- to capture areas encompassing both the place of work and the place of residence of most individuals. There are about 300 commuting zones in France.

[10]Since 2017, the database reports two firm identifiers for each TWA contract: the one of the employer - the TWA - and the one of the client - the user firm.

procedure allows us to net-out from the wage gap all differences explained by the composition of firms hiring TWA workers, which are typically the largest and most productive ones. Second, we need to follow workers over time and to observe multiple individuals switching across contracts, occupations and firms in order to identify wage premia net of a rich set of fixed effects. The administrative records published by the French statistics office (INSEE) provide consistent individual identifiers for only $1/12^{th}$ of the total workforce, which results in a connected set that is too sparse to identify our parameters of interest. We therefore apply the procedure described by Babet et al. (2022) to recover the exhaustive worker panel from the *DADS* data over the years 2017 to 2019.[11] In the final dataset obtained from this procedure, we observe over 2 million workers that hold both TWA contracts and in-house contracts over the period, and the vast majority of them also switches across firms and occupations when changing contract type, thus providing substantial variation for the analysis (see Appendix A.2 for more summary statistics).[12]

3 Wages of in-house and temp workers

3.1 Average wage gap

We start by estimating the following AKM model:

$$\log(w)_{ioet} = \beta_1 Inhouse_{ioet} + \beta_2 X_{ioet} + \gamma_t + \gamma_i + \gamma_e + \gamma_o + \epsilon_{ioet}, \tag{1}$$

where $\log(w)_{ioet}$ measures the logarithm of the hourly wage paid to worker i in occupation o, establishment e and time t, $Inhouse_{ioet}$ is a dummy identifying that the worker is under an in-house contract, and X_{ioet} controls for individual and contract-level characteristics such as age and age squared, gender, a dummy for open-ended

[11] The individual worker identifiers included in the exhaustive employer-employee data are not consistent across years. However, Babet et al. (2022) showed that the vast majority of individuals can be identified from one year to the next using the available information on their demographics, their firm of employment and their occupation. We therefore apply their codes to construct a worker-level panel of all the French labor force. We finally exclude the public sector because of their different wage setting mechanisms. More details on the data construction are available in Appendix A.2.

[12] One important caveat of the data is that if the TWA worker is employed by different using firms over the same year, without changing the TWA that employs him, only the user firm where the temp worker worked the longest number of days will be recorder, assigning to it all of the working hours and salaries perceived while working for other clients as well. This caveat might introduce some noise in the analysis, but we do not expect it to systematically bias our results.

contracts, and the count of number of days worked on the job in the year. We further include increasingly demanding levels of fixed effects, including year (γ_t), worker (γ_i), user establishment (γ_e) and occupation (γ_o) fixed effects.[13] An important element for identification is that movements across contracts are not correlated with unobserved time-varying individual characteristics. If workers systematically switch from TWA contracts to in-house contracts when they experience an unobserved productivity growth, this would create some endogeneity in the estimation of β_1. To get a sense of whether transitions from TWA to in-house contracts constitute typical career-ladders, Appendix Table A.3.1 reports the frequency of movements across contract types. What we observe is that, especially within fixed-term contracts, workers switch as frequently from in-house to TWA than the other way around. This observation alleviates the concern of endogenous transitions. Finally, one might wonder whether the type of individuals or the type of establishments that engage in in-house contracts are very different from those engaging in TWA contracts. If this was the case, it would undermine the scope for comparability of the two work arrangements. To alleviate this concern, we estimate a standard AKM model with individual and establishment fixed effects, as well as the same time varying controls included in equation (1), and we plot the distribution of the fixed effects for different types of contracts. Appendix Figure A.3.1 shows the results. We see that the distribution of establishment fixed effects is highly comparable across open-ended in-house (CDI), fixed-term in-house (CDD) and TWA contracts, with only a slight over-representation of TWA contracts towards more productive firms. When it comes to individual fixed effects, we see that workers with CDI contracts are skewed towards the right, but the distribution among CDD and TWA workers is almost exactly the same.

Table II reports the estimation for β_1 when we only control for time FE and the dummy for open-ended contracts (Column 1), when we add all individual and contract level controls in X_{ioet} (Column 2), when we add worker FE (Column 3), user establishment FE (Column 4), and occupation FE (Column 5). Column (6) reproduces the specification of Column (5) but restricts the sample of in-house contracts to fixed-term ones (CDD). Interestingly, the raw comparison reveals that on average in-house contracts pay about 0.3% less than TWA contracts, but controlling for age, gender and contract characteristics already tilts the difference in favor of in-house workers (+0.16%). When we control for individual fixed effects the difference becomes slightly smaller,

[13]We do not include commuting zone fixed effects because they are absorbed by the establishment fixed effects.

around 0.1%. This suggests that part of the difference is explained by the fact that less productive individuals are more likely to be employed in TWA contracts. However, this low coefficient masks another difference: the fact that large and more productive firms are more likely to use TWA contracts. Once we control for both individual and user establishment FE, we obtain a wage-gap of 3.6%, which shrinks to 3.3% once we also control for occupation FE. These estimates are obtained using over 27 million observations spanning roughly 7 million individuals and 1.2 million user establishments in the French private sector. Restricting the comparison group to short term contracts considerably shrinks the number of observations, but give rise to a similar premium although somewhat smaller (2.5%). These results confirm the finding of Drenik et al. (2020): on average, temp workers are paid less than comparable in-house workers employed in the same firms and under similar contract length.

TABLE II. Wage impact of temporary work contracts

	(1) log(w)	(2) log(w)	(3) log(w)	(4) log(w)	(5) log(w)	(6) log(w)
In house	-0.00339***	0.00163***	0.000930***	0.0365***	0.0330***	0.0246***
	(0.000218)	(0.000213)	(0.000158)	(0.000197)	(0.000201)	(0.000255)
Controls		yes	yes	yes	yes	yes
Indiv. FE			yes	yes	yes	yes
Using estab. FE				yes	yes	yes
Occup. FE.					yes	yes
N	27,367,221	27,367,221	27,367,221	27,118,802	27,118,802	10,036,964
R2	0.107	0.160	0.828	0.861	0.862	0.685

Standard errors in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
Column 1 controls for a dummy for open-ended contracts and year fixed effects only. Column 2 adds controls for gender, age and average hours worked per day, Column 3 adds individual fixed effects. Column 4 adds user establishment fixed effects. Column 5 adds occupation fixed effects. Finally, Column 6 uses the same model of column 5 but restricts the sample to fixed-term contracts.

3.2 Wage gap heterogeneity

To analyze the heterogeneity of the wage gap, we extend the AKM model presented in the previous sub-section to recover establishment and market-specific wage gaps controlling for possible confounding factors. We compute wage gaps at three different levels of aggregation : i) establishment level, ii) establishment $\times$ occupation level, iii) commuting zone × occupation × firm productivity group level,[14] as follows:

$$\log(w)_{ioet} = \beta_2 X_{ioet} + \gamma_e^{C_{ioet}} + \gamma_t + \gamma_i + \epsilon_{ioet} \tag{2}$$

$$\log(w)_{ioet} = \beta_2 X_{ioet} + \gamma_{eo}^{C_{ioet}} + \gamma_t + \gamma_i + \epsilon_{ioet} \tag{3}$$

$$\log(w)_{iozpt} = \beta_2 X_{iozpt} + \gamma_{zop}^{C_{iozpt}} + \gamma_t + \gamma_i + \epsilon_{iozpt} \tag{4}$$

The superscript $C_{ioet} \in H, T$ indicates whether worker i is employed with a TWA contract T or an in-house contract H. $\gamma_e^{C_{ioet}}$ are contract-specific establishment effects, $\gamma_{eo}^{C_{ioet}}$ are contract-specific establishment-occupation effects, and $\gamma_{zop}^{C_{iozpt}}$ are contract-specific commuting zone-occupation-productivity group effects. The sample is each time restricted to the largest connected set according to the level of analysis.

We then recover the full distribution of cell-specific wage gaps by subtracting the TWA-specific fixed effects from the in-house specific fixed effects : $\gamma_x^H - \gamma_x^T$ for $x \in e, eo, zop$. In practice, the wage gaps obtained here are equivalent to extending equation (1) by interacting the TWA contract dummy with the entire battery of establishment, establishment-occupation or commuting zone-occupation-productivity group fixed effects.

Table III summarizes the wage gap distribution obtained with each one of the three models presented, both using all in-house contracts and restricting to fixed-term ones. Figure II shows the distributions in a graph for the full sample, and Appendix figure A.3.2 show the distributions obtained when we restrict the sample to fixed-term contracts. Regardless of the level of analysis chosen, we confirm the presence of substantial heterogeneity, with more than 25% of the cells presenting higher wages for temp workers than for in-house workers.

[14] We define productivity based on total factor productivity - TFP - computed under the assumption of a Cobb-Douglas production function and combining all the firms belonging to the same group. We then split all firms into two equally sized groups along median productivity, and we superpose this dimension to the occupation × commuting zone cells.

TABLE III. Summary statistic on firms' and markets' wage gaps

	mean	p25	p50	p75	sd	N
Panel a) Wage gaps using all in-house contracts						
Wage gaps by estab	0,038	-0,044	0,033	0,115	0,146	165437
Wage gaps by estab - occup	0,042	-0,059	0,031	0,131	0,175	152732
Wage gaps by CZ - occup - prod. group	0,022	-0,033	0,018	0,074	0,115	27190
Wage gaps by 20 estab. classes	0,019	-0,0004	0,016	0,039	0,024	20
Panel b) Wage gaps using only fixed term contracts						
Wage gaps by estab	0,029	-0,056	0,019	0,103	0,151	85512
Wage gaps by estab - occup	0,027	-0,063	0,018	0,107	0,161	54886
Wage gaps by CZ - occup - prod. group	0,007	-0,055	0,003	0,063	0,131	22563

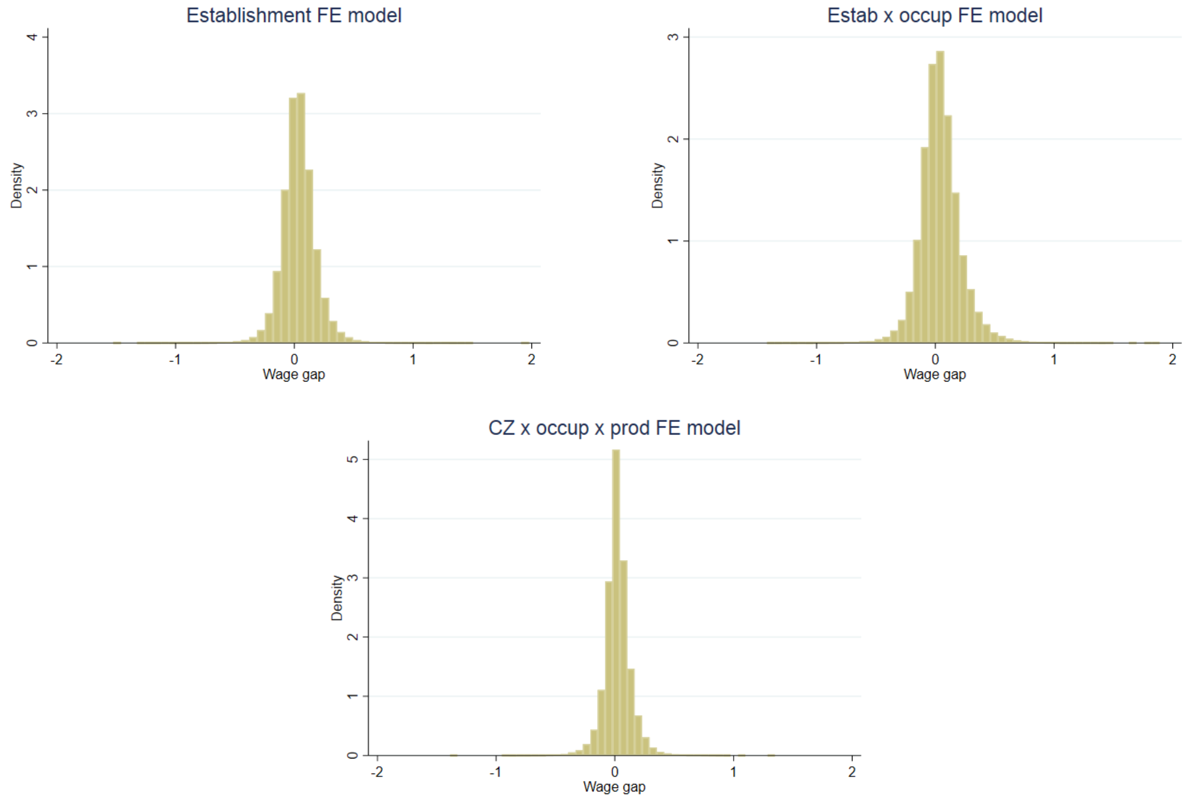
Note: This table reports the summary statistics of the cell-specific wage gaps obtained by subtracting the TWA-specific premium within a given establishment, establishment-occupation, and CZ-occupation-productivity group from the in-house specific premium of the same entity, as reported in equations (2), (3) and (4). The last line shows the distribution of wage gaps computed within 20 firm classes in the spirit of Bonhomme et al. (2019). When we restrict in-house contracts to only fixed-term ones the sample of cells for which we can compute the wage gaps shrinks considerably, but the distributions remain qualitatively similar.

Finally, we conduct a robustness test to show that cells with negative wage gaps are not driven by measurement error and small sample bias. We classify firms into 20 clusters defined by their average level of wages among in-house workers, in the spirit of Bonhomme et al. (2019). We then adopt the same methodology described above, but where instead of introducing firm x contract fixed effects, we introduce firm cluster x contract fixed effects (40 in total, 20 for each contract type). Complete results are reported in Appendix A.3 and the obtained distribution is summarized in Table III. We show that we still recover about 25% of cells with wages in favor of temp workers. The latter are concentrated in the bottom clusters, which are those combining firms with low average pay levels.

3.3 Factors correlated with the wage gap heterogeneity

We find that the average level of rent pass-through from in-house workers to temp workers is less than one, similarly to Drenik et al. (2020) – see Appendix A.3. This can be consistent with the common interpretations of the wage gap as evidence of differential rent sharing between in-house and temp workers within using firms or of fairness concerns of companies towards in-house workers. However, these interpretations are unable to explain the considerable proportion of cells with negative wage gaps, since they can only rationalize why temp workers are paid less than in-house

FIGURE II. Distribution of wage gaps



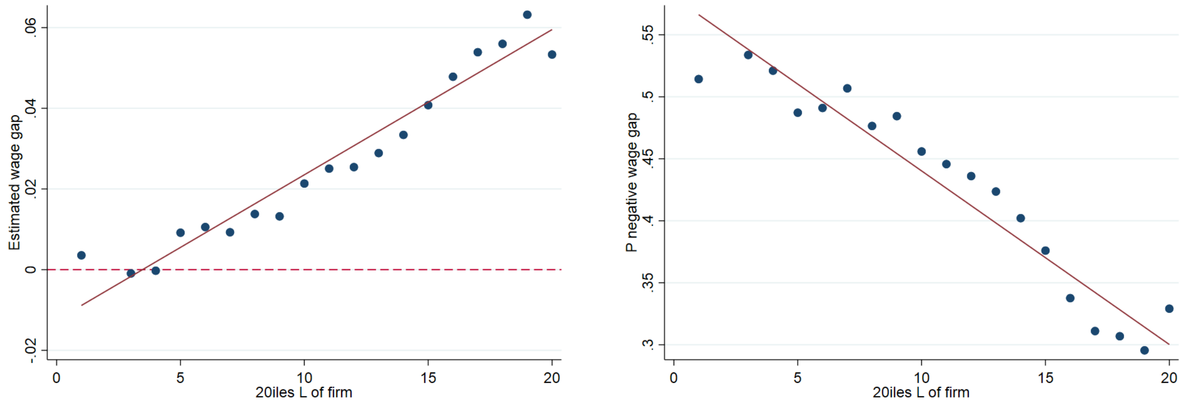
Notes: Distribution of the wage gaps between in-house and temporary workers recovered using equations (2), (3) and (4) on the entire sample.

workers. Additionally, these explanations only consider the characteristics of the using firms, abstracting away any role played by the temporary work agencies. In what follows, we document the relationships between the wage gap and the characteristics of user firms and TWAs to provide further evidence that negative wage gaps do not stem from measurement error but from labor market characteristics that can be explained by a model.

Figure III correlates the wage gaps obtained from the AKM regression with 20iles of establishment size. The picture shows that wage gaps are strongly positively correlated with larger firms. Similarly, we find 55% of negative wage gaps within firms at the bottom of the size distribution, and only 30% for firms at the top of the distribution. Appendix Figure A.3.5 shows similar patterns if we correlate the wage gaps to 20iles of firm revenues per worker. Finally, Figure A.3.6 confirms that the Bonhomme et al. (2019) clusters with wage gaps in favor of TWA workers are concentrated in the lower paying classes. All in all, these results confirm that the presence of a significant portion of firms where TWA workers are paid more than in-house is not driven by measurement error or small sample bias, but rather by some fundamental characteristics of using firms.

FIGURE III. Correlation between wage gaps and firm size

(a) Wage gaps and firm size　　(b) Sh. negative wage gaps and firm size



Note: This figure shows how the wage gap between in-house and TWA workers obtained from AKM regressions correlates with firm size. The latter is split into vintiles for simplicity.

To evaluate whether the identity of the TWA also matters for explaining the wage of temp workers, we estimate the following model, restricting the sample to the largest connected set among temp workers :

$$\log(w)^T_{ioeat} = \beta_2 X_{ioeat} + \gamma_e + \gamma_a + \gamma_i + \gamma_o + \gamma_t + \epsilon_{ioeat} \tag{5}$$

Where γ_i are the individual fixed effects, γ_e are the using establishment fixed effects, and γ_a are the TWA fixed effects. We also control for time and occupation fixed effects, as well as for the same individual and contract characteristics added in the previous models. Table IV reports the portion of the total variance in TWA wages explained by each dimension of fixed effects, and compares it with a "classic" in-house workers wage decomposition into establishment and individual components.

A recent literature underlines how the variance decomposition of wages using AKM models is subject to limited mobility bias, which has the tendency to over-estimate the variances of each component and under-estimate the covariances between them due to measurement error (Bonhomme et al., 2019; Kline et al., 2020). We thus adopt one of the split-sampling corrections put forward by Babet et al. (2022) , which they name "firm-splitting". The latter consists in randomly splitting individuals into two samples, keeping the entire career of each individual within the same sample, and stratifying the randomization by firms. The procedure of randomly splitting individuals instead of observations allows to increase the connectivity within each set, at the expense of not being able to correct the variance of the worker component, since each worker fixed effect is only estimated in one sample. Nonetheless, the firm-level stratification maximizes the odds of estimating the same firm fixed effect in both samples, using an entirely different set of workers. The covariance between the fixed effects of the same firm estimated from the two samples thus gives the true variance of the firm component, since the measurement errors in the two samples are uncorrelated. In our decomposition of TWA workers wages, we first stratify the random sampling of individuals by using firms, to obtain the true variance of the using firm component, and then we repeat the procedure stratifying by TWA, to obtain the true variance of the TWA component. We thus estimate in total 4 regressions on about 50% of the sample each.[15]

TABLE IV. Wage variance decomposition

	Uncorrected		Corrected	
	variance	share of tot variance	variance	share of tot variance
Temp workers				
log wage	0.036			
worker FE	0.016	44%		
Firm FE	0.006	17%	0.005	14%
TWA FE	0.002	6%	0.002	6%
remaining variance	0.012	32%		
In-house workers				
log wage	0.187			
worker FE	0.113	60%		
Firm FE	0.022	12%	0.012	6%
remaining variance	0.052	28%		
In-house fixed term workers				
log wage	0.071			
worker FE	0.043	61%		
Firm FE	0.023	33%	0.009	13%
remaining variance	0.005	7%		

Note: This table reports the decomposition of the wage variance for TWA workers according to the portion explained by individual, establishment and TWA effects, following equation (5). It compares the results with the ones obtained from estimating a similar model on in-house workers and in-house fixed-term workers, dropping the TWA effects. The first two columns present the raw (uncorrected) variances, while the last two columns present the variances corrected for limited mobility bias using a single sample split following Babet et al. (2022).

Table IV presents the results and compares them with the variance decomposition of in-house wages. The variance of TWA workers' wages is much lower than for in-house workers, and a much lower share is explained by individual characteristics

[15]For each of the sub-samples we estimate the model on the largest set of connected components.

TABLE V. TWA wage premia and TWA filling rate

	(1)	(2)	(3)	(4)
	TWA FE, job filling rate regression			
	OLS	OLS	OLS	OLS
TWA FE, wage regression	0.235**	0.248**	0.220*	0.239**
	(0.104)	(0.115)	(0.114)	(0.115)
Log empl TWA			0.0111**	0.0106*
			(0.00555)	(0.00544)
Log CA/L TWA				0.0130**
				(0.00527)
Constant	-0.125***	-0.125***	-0.231***	-0.320***
	(0.00546)	(0.000455)	(0.0530)	(0.0619)
Observations	7,046	7,037	7,035	6,750
R-squared	0.001	0.062	0.063	0.065
CZ Fixed effects		✓	✓	✓

Note: This table reports the correlation between the TWA fixed effects obtained from a job filling rate equation controlling for TWA and using firm fixed effects and the TWA effects obtained from the TWA worker wage equation with TWA, using firm and individual FE.

(44% vs 60%). A larger share is thus explained by using firm characteristics (14% vs 6% when taking the corrected variance). In-house fixed-term workers lay somewhat in between TWA workers and in-house open-ended workers. More importantly, a non-negligible share of temp worker wages is explained by the TWA fixed effects: 6% of the total, amounting to almost half of the role of using establishments. This suggests that TWAs are important actors in determining the wage of their employees. While the importance of the using firm component shrinks once we control for limited mobility bias, the importance of the TWA component remains unchanged. Finally, Table V correlates the estimated TWA rent ($\hat{\gamma}_a$) with an estimation of the TWA vacancy filling rate recovered by regressing the job filling rate on TWA fixed effects and client establishment fixed effects.[16] The table shows a clear positive correlation between the fixed effect of the TWA on the wages of its temp workers and the rate at which it fills job vacancies. The table also shows that this correlation remains true

[16]This analysis is computed using data from the French employment office *Pôle Emploi* reporting information on all vacancies posted on their platform, including the identifier of the employing establishment and, in the case of TWA jobs, the identifier of the client establishment. The job filling rate is computed as the log of 1 over the vacancy length. Here there is no scope for worker fixed effects because the match is yet to be realized.

even after controlling for commuting zone fixed effects, log employment of the TWA establishment, and log capital per worker of the TWA firm.

Guided by this empirical evidence, in the next section we put forward a model rationalizing why identical in-house workers and temp workers can be paid differently within the same firm and occupation, and why the pay gap can vary considerably across firms and markets, to the point of reversing sign in some instances.

4 A model

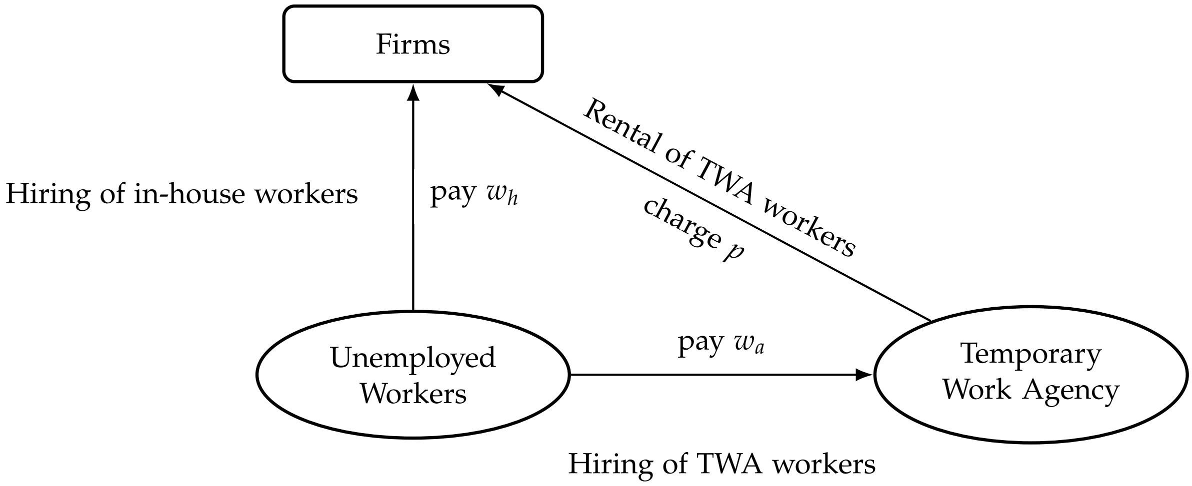
We begin by introducing the general structure of the model, summarized in Figure IV, before detailing the behaviors of workers, firms, and TWAs. We then present the labor market equilibrium and its comparison with a socially efficient allocation chosen by a planner who maximizes the production minus the cost of capital and job vacancies.

4.1 Framework

The framework is a directed job search model in continuous time, where $\mathcal{N}$ risk-neutral workers, each with an infinite lifespan, participate. Time is modeled as continuous. The economy features a numéraire good produced from capital and labor. A normalized exogenous number of identical firms, set to one, can create jobs, employ in-house workers, and procure labor services of temp workers through Temporary Work Agencies (TWAs). Similarly, an exogenous number of identical TWAs, also normalized to one, offer the services of temp workers to firms in a perfectly competitive market. Within this job market, firms and TWAs seek workers by advertising job vacancies. Workers are free to apply for positions with either firms or TWAs. Firms utilize a constant return to scale technology to produce $y > 0$ units of the final good per unit of time for each filled job. Filled jobs are subject to destruction at an exogenous Poisson rate q.

Job creation incurs an investment of $k \geq 0$ units of the numéraire good implying a flow cost of capital equal to rk, where r stands for the interest rate. The capital k is required regardless of whether the job remains vacant or becomes filled. To recruit an in-house worker to fill a vacancy, a firm posts a vacancy with an associated marginal cost $C'(\mathcal{V}_h)$, where $\mathcal{V}_h$ denotes the number of vacancies for in-house positions, and $C(\mathcal{V}_h)$ represents the cost function. This function is characterized by the conditions:

FIGURE IV. STRUCTURE OF THE MODEL



$C(0) = 0$, $C' > 0$, $C'' > 0$, and $\lim_{\mathcal{V}\to 0} C'(\mathcal{V}) = 0$.[17]

Firms have the option to rent the services of temp workers employed by TWAs. The market for renting these services is perfectly competitive. The cost for a firm to post its vacancy through a TWA is effectively zero,[18] and the firm incurs a cost of p payable to the TWA only when a temp worker fills the job. To prevent user firms from seeking in-house workers for vacancies initially posted at the TWAs, contracts may specify that user firms owe compensation to the TWAs for any cancellation of their demand. This compensation which is not paid under equilibrium conditions does not influence the equilibrium price paid to the TWAs.

The increasing marginal cost of posting vacancies for firms seeking to recruit internal workers on their own can stem from the fact that they must mobilize internal human resources that are not necessarily specialized in this type of activity. The specialization of TWAs allows them to increase their activity without being confronted with these difficulties. Therefore, we assume that the TWAs post vacant jobs at constant marginal cost, equal to κ per vacancy to the TWAs.

Wages for each vacancy, which are set by employers, are fixed and non-negotiable, creating distinct submarkets for each wage level and type of job. Unemployed workers are free to search across all submarkets for job opportunities. The matching process within each submarket is governed by a matching function exhibiting constant

[17] The convexity hypothesis of the job vacancy cost function is empirically relevant to explain the hiring behavior of firms. See, among others Coşar et al. (2016); Gavazza et al. (2018); Manning (2006); Merz and Yashiv (2007).

[18] This assumption is made for the sake of simplicity. Assuming the presence of a positive fixed cost does not alter our key findings.

returns to scale. This function dictates that vacancies posted by firms for in-house employment are filled at an endogenous Poisson rate $m(\theta) > 0$, where $m'(\theta) < 0$ and $m''(\theta) < 0$, and $\theta \geq 0$ represents labor market tightness — the ratio of job vacancies to unemployed workers within a submarket. Unemployed workers find jobs at rate $\theta m(\theta)$.

Vacancies posted by TWAs are filled at an endogenous rate of $\alpha m(\theta) > 0$. Here, $\alpha > 0$ acts as a scalar adjusting for the differential in search efficiency between firms and TWAs. Notably, α may be less than one, reflecting situations where TWAs are less efficient than firms. Additionally, a divergence in human resource management costs exists between the two entities: TWAs bear a fixed cost per filled job denoted by $c_a \geq 0$, whereas firms managing in-house workers incur a cost of $c_h \geq 0$.

Now, we will define the objectives and behaviors of workers, firms and TWAs in a frictional labor market with in-house and temp workers.

4.2 Value functions and offered wages

4.2.1 Workers

Let W_u denote the expected value from unemployment at the start of the period. In different labor submarkets, there are varying potential values of wage w and market tightness θ. Workers find jobs at rate $\theta m(\theta)$ in a submarket with tightness θ, and those who do not find a job receive unemployment income b. The arbitrage condition is given by:

$$rW_u = b + \theta m(\theta) \left(W(w) - W_u \right), \quad \forall (w, \theta) \tag{6}$$

where $W(w)$, the expected value for employed workers at wage w, satisfies:

$$rW(w) = w + q \left(W_u - W(w) \right) \tag{7}$$

This condition outlines a negative relationship between wage and labor market tightness across submarkets, as higher wages attract more unemployed workers to those submarkets.

4.2.2 Firms

There is an exogenous number of identical firms normalized to one. Each firm can produce with $\mathcal{L}_h \geq 0$ in-house workers and $\mathcal{L}_a \geq 0$ temp workers. The number of workers employed by each firm is

$$\mathcal{L} = \mathcal{L}_h + \mathcal{L}_a$$

Firms choose the number of in-house and temp job vacancies. They also choose the wage associated with their in-house job offers. Let us denote by $\mathrm{d}t \to 0$ a small interval of time and by $x^+ - x$ the variation of variable x over the time interval $\mathrm{d}t$. The value function of a firm satisfies:

$$\begin{aligned}(1 + r\,\mathrm{d}t)\,\Pi\left(\mathcal{L}\right) = \max_{(\mathcal{V}_h \geq 0, \mathcal{V}_a \geq 0, w)} \Big\{ & y\mathcal{L} - (w_h + c_h)\,\mathcal{L}_h - C(\mathcal{V}_h) \\ & -rk\left(\mathcal{L} + \mathcal{V}_h + \mathcal{V}_a\right) - p\mathcal{L}_a \Big\}\,\mathrm{d}t + \Pi\left(\mathcal{L}^+\right)\end{aligned}$$

subject to the arbitrage condition (6) and the law of motion of in-house and temp jobs:

$$\begin{aligned}\mathcal{L}_h^+ &= (1 - q\mathrm{d}t)\,\mathcal{L}_h + \mathcal{V}_h m(\theta_h)\mathrm{d}t \\ \mathcal{L}_a^+ &= (1 - q\mathrm{d}t)\,\mathcal{L}_a + \alpha\mathcal{V}_a m(\theta_a)\mathrm{d}t\end{aligned}$$

For the sake of clarity, we describe here the equilibrium in which firms post in-house and temp job vacancies. Firms may hire both temp and in-house workers because the marginal cost of posting vacancies for in-house workers is increasing, while the marginal cost of employing temporary workers, equal to the price paid to TWAs, is considered by the firm as an independent variable from its activity. The other equilibria and detailled derivations are described in Appendix B.

For an interior solution, the first order conditions of the firms' maximization problem imply that they offer the wage:

$$w_h = \eta\left(y - rk - c_h - rW_u\right) + rW_u \tag{8}$$

At the optimum, firms equalize the marginal cost of job creation to its marginal return. To create a job, firms invest and then pay the flow cost of capital equal to rk, whether the job is vacant or filled. The vacancy cost is equal to $C'(\mathcal{V}_h)$ if they look for an in-house worker. The expected marginal return of a vacant job is equal to the job filling rate $m(\theta_h)$ times the discounted difference between marginal productivity, y, and the cost of labor and capital $w_h + c_h + rk$. Therefore, the equalization of the marginal cost of job creation for in-house workers to their marginal return yields, using the definition (8) of the optimal wage:

$$C'(\mathcal{V}_h) + rk = (1-\eta)m(\theta_h)\frac{y - rk - rW_u - c_h}{r+q} \tag{9}$$

When a firm seeks a temp worker, the marginal cost of a vacant job is represented by the flow cost of capital, rk. The marginal return is determined by the job filling rate $\alpha m(\theta_a)$ multiplied by the discounted difference between the marginal productivity y, and the sum of the flow cost of capital rk and the price p paid to the TWA if the job is successfully filled. The equilibrium condition, equating the marginal cost to the marginal return of temp job vacancies, dictates the demand of firms for temp workers as follows:

$$rk = \alpha m(\theta_a)\frac{y - rk - p}{r+q} \tag{10}$$

4.2.3 TWAs

TWAs employ temp workers to provide labor services to firms. The TWAs post job vacancies at a unit cost of κ and offer a wage w_a to recruit temp workers for user firms, which pay a price p if a temp worker is recruited. The probability of filling job vacancies is $\alpha m(\theta_a)$, and the TWAs incur a human resource management cost c_a per temp worker. Therefore, the value of vacancies posted by the TWAs is given by:

$$rV_a = \max_{w_a} -\kappa + \alpha m(\theta_a)\left(\frac{p - w_a - c_a}{r+q} - V_a\right) \quad \text{subject to (6)} \tag{11}$$

The wage offered to temp workers is determined by:

$$w_a = \eta\left(p - c_a - rW_u\right) + rW_u \tag{12}$$

The market for temp workers operates under a free entry condition, implying that TWAs will continue to create vacancies until the value of their vacant jobs is zero ($V_a = 0$). This condition, combined with the wage expression w_a, defines the equation for the supply of vacancies for temp workers:

$$\frac{\kappa}{\alpha m(\theta_a)} = (1-\eta)\left(\frac{p - c_a - rW_u}{r+q}\right) \tag{13}$$

4.3 Labor market equilibrium

In equilibrium, the demand for and supply of vacancies for temp workers are equal and workers seeking employment receive the same expected utility across all submarkets.

The equilibrium between the demand for temp worker vacancies by user firms and their supply by TWAs allows for the substitution of the price p paid by firms for the services of temp workers – defined by the demand equation (10) – into the wage equation (12). Consequently, the wage offered to temp workers is determined as follows:

$$w_a = \eta \left(y - rk - c_a - rW_u - rk \frac{r+q}{\alpha m(\theta_a)} \right) + rW_u \tag{14}$$

This equation demonstrates that the wages of temp workers depend not only on the characteristics of client firms but also on those of TWAs, as evidenced in the empirical analysis. Specifically, the wages of temp workers rise with the speed at which the agencies fill positions, as shown in Table V. This equation enables a comparison between the wages of in-house and temp workers, leading to the following proposition:

Proposition 1. *The wage differential between in-house and temp workers is influenced by rk, the maintenance cost of vacant jobs, $\alpha m(\theta_a)$, the job filling rate of the TWAs, and $c_a - c_h$, the disparity in human resources management costs between TWAs for temp workers and firms for in-house workers.*

Proof. From equations (8) and (14) the wage gap between in-house and temp workers is equal to:

$$w_h - w_a = \eta \left(rk \frac{r+q}{\alpha m(\theta_a)} + c_a - c_h \right) \tag{15}$$

□

Now, we can define the conditions which recursively determine the equilibrium values of: i) the tightness on the submarket for temp jobs from the equality between the supply and demand for temp jobs; ii) the equilibrium value of the tightness for the submarket for in-house jobs from the arbitrage condition of unemployment workers; iii) the number of vacancies for in-house jobs from the equality of the supply and demand for those vacancies (see Appendix B for details):

$$\begin{cases} \underbrace{\kappa + rk}_{\text{Cost of temp job vacancies}} = \underbrace{\alpha m(\theta_a)\,(1-\eta)\,\dfrac{y - rk - c_a - b}{r + q + \eta\theta_a m(\theta_a)} + \eta\dfrac{r + q + \theta_a m(\theta_a)}{r + q + \eta\theta_a m(\theta_a)}rk}_{\text{Expected profits of temp job vacancies}} \\ \underbrace{\dfrac{\eta\theta_h m(\theta_h)\,(y - rk - c_h - b)}{r + q + \eta\theta_h m(\theta_h)}}_{\text{Expected gains of seeking in-house jobs}} = \underbrace{\dfrac{\eta\theta_a m(\theta_a)}{r + q + \eta\theta_a m(\theta_a)}\left(y - rk - c_a - b - \dfrac{r+q}{\alpha m(\theta_a)}rk\right)}_{\text{Expected gains of seeking temp jobs}} \\ \underbrace{C'(\mathcal{V}_h) + rk}_{\text{Cost of in-house job vacancies}} = \underbrace{\dfrac{m(\theta_h)\,(1-\eta)}{r + q + \eta\theta_h m(\theta_h)}\,(y - rk - c_h - b)}_{\text{Expected profits of in-house job vacancies}} \end{cases} \tag{16}$$

The top equation, derived from equations (10) and (13), specifies the labor market tightness θ_a for temp workers compatible with the demand and supply of temp job vacancies. The left-hand side represents the combined costs to firms and TWAs for maintaining a vacancy for temp workers. The right-hand side corresponds to the joint expected profits for TWAs and firms, calculated as the vacancy filling rate multiplied by the share $(1-\eta)$ of the job surplus accruing to TWAs and firms, multiplied by the value of the joint surplus. Additionally, the last term of the right-hand side shows that the cost of maintaining vacant temp jobs for user firms enhances the joint expected profits from temp job vacancies at the expense of the remuneration of temp workers. This effect arises because this cost reduces the price p paid by user firms to TWAs, as outlined in equation (10), which subsequently impacts the wage of temporary workers, as detailed in equation (14). The top equation defines a unique value for θ_a, assuming it exists.

The relationship between labor market tightness in submarkets for in-house and temp workers, displayed in the middle equation, is determined through the arbitrage condition (6), in conjunction with wage determinations in equations (8) and (14). The expected gains from seeking in-house jobs (on the left-hand side of the equation) or temp jobs (on the right-hand side) are equal. This equation yields a unique value for θ_h, given a specific θ_a.

Lastly, the number of vacancies for in-house workers, $\mathcal{V}_h$, is defined through equation (9).

Once the equilibrium values of labor market tightness, θ_a and θ_h, and the number of vacancies for in-house workers, $\mathcal{V}_h$, are established, we can derive the number of vacancies for temporary workers ($\mathcal{V}_a$), the number of in-house workers ($\mathcal{L}_h$), the number of temporary workers ($\mathcal{L}_a$), and the number of unemployed workers seeking in-house ($\mathcal{U}_h$) and temp jobs ($\mathcal{U}_a$). These are determined by the labor market tightness definitions, the flow equilibrium conditions:

$$
\begin{aligned}
\mathcal{U}_h\theta_h &= \mathcal{V}_h \\
\mathcal{U}_a\theta_a &= \alpha\mathcal{V}_a \\
q\mathcal{L}_h &= \theta_h m(\theta_h)\mathcal{U}_h \\
q\mathcal{L}_a &= \alpha\theta_a m(\theta_a)\mathcal{U}_a
\end{aligned}
$$

and the resource constraint:

$$
\mathcal{N} = \mathcal{U}_a + \mathcal{U}_h + \mathcal{L}_h + \mathcal{L}_a.
$$

4.4 Efficiency

4.4.1 Constrained efficient allocation

The constrained efficient allocation can be obtained as the result of the choice of a planner who selects the number of vacancies for temp and in-house jobs, as well as the number of job seekers for each, aiming to maximize the discounted value of the output minus the costs of capital and vacant jobs. This optimization process yields the following system of equations, which determine the market tightness values for temp and in-house jobs, and the number of in-house job (see Appendix B.3):

$$
\begin{cases}
\underbrace{\kappa + rk}_{\text{Cost of temp job vacancies}} = \underbrace{\alpha m(\theta_a^*)\,(1-\eta)\,\dfrac{y - rk - c_a - b}{r + q + \eta\theta_a^* m(\theta_a^*)}}_{\text{Expected gains of temp job vacancies}} \\[2ex]
\underbrace{\dfrac{\theta_h^* m(\theta_h^*)\,(y - rk - c_h - b)}{r + q + \eta\theta_h^* m(\theta_h^*)}}_{\text{Expected gains of seeking in-house jobs}} = \underbrace{\dfrac{\theta_a^* m(\theta_a^*)\,(y - rk - c_a - b)}{r + q + \eta\theta_a^* m(\theta_a^*)}}_{\text{Expected gains of seeking temp jobs}} \\[2ex]
\underbrace{C'(\mathcal{V}_h^*) + rk}_{\text{Cost of in-house job vacancies}} = \underbrace{\dfrac{m(\theta_h^*)\,(1-\eta)}{r + q + \eta\theta_h^* m(\theta_h^*)}\,(y - rk - c_h - b)}_{\text{Expected gains of in-house job vacancies}}
\end{cases}
\tag{17}
$$

The top equation of each of the two systems, (16) and (17), represents the equality between the marginal cost of temp job vacancies, on the left-hand side, and the marginal expected gain, on the right-hand side. For the social planner, the marginal cost includes the cost of maintenance of job vacancies, rk, plus the cost of vacancies for the TWAs, equal to κ. This cost is equivalent to the joint costs for user firms and TWAs in the decentralized equilibrium. However, the expected gains of temp job vacancies differ from the perspective of the social planner because the wage of temp workers is reduced by the maintenance cost of vacancies accruing to user firms in the decentralized equilibrium. This mechanism, which enhances the incentives of user firms to rely on temp jobs in the decentralized equilibrium, is socially inefficient, as evidenced by the comparison of the top equations of systems (16) and (17).

The middle equation of the system (17) signifies the equality between the marginal return of seeking temp and in-house jobs. A comparison with the decentralized equilibrium reveals that the returns from seeking temp jobs are too low, relative to its socially efficient level, because the wage of temp workers is diminished by the maintenance cost of temp job vacancies for user firms.

The bottom equation, determining the optimal number of in-house job vacancies, retains the same expression in both the constrained efficient solution and in the decentralized equilibrium.

4.4.2 Comparison of the decentralized equilibrium with the constrained efficient allocation

The comparison of the systems of equations (16) and (17), shows that, when $k = 0$, the constrained efficient and the decentralized equilibrium values of $(\theta_h, \theta_a, \mathcal{V}_h)$ are determined by the same conditions, which implies that the decentralized equilibrium is constrained efficient. The sole source of inefficiency arises from the distortion due to the maintenance cost of temp job vacancies for user firms, which diminishes the wage of temp workers relative to that of in-house workers.

Proposition 2. *The decentralized equilibrium is constrained efficient if and only if the cost of maintenance of vacant temp jobs for user firms, rk, is equal to zero.*

The inefficiency of the decentralized equilibrium can be explained as follows: firms hire temp workers, whose wage is negatively impacted by the maintenance cost of temp vacant jobs for user firms, because they bear a fraction η of the job maintenance cost – see the right-hand side of the top equations of systems (16) and (17) – with the TWAs. This scenario arises because rk diminishes the demand for temp workers, which in turn lowers the price paid to the TWAs for using the services of temp workers – see equation (10) – and consequently, the wages of temp workers – see equation (14). The expression of the wage gap $w_h - w_a$ – see equation (15) – implies the following result.

Proposition 3. *The wage gap between in-house and temp workers stems from the inefficiency induced by the maintenance cost of temp job vacancies for user firms and from the difference in the cost of human resources management between the TWAs for temp workers and firms for in-house workers, which does not induce inefficiency of the decentralized equilibrium.*

The inefficiency of the decentralized equilibrium has also consequences on the number of jobs which can be summarized as follows

Proposition 4. *For all parameter set values, the number and the share of in-house jobs in the decentralized equilibrium are either equal to or higher than those in the constrained efficient solution.*

Proof. See appendix B.4 □

The insufficient share of temp jobs and the excess of in-house jobs in the decentralized equilibrium are the consequence of the low wages of temp workers. On the one hand, the low wages of temp jobs induce firms to rely too much on temp jobs. On the other hand, these wages prompt temp workers to direct their search toward in-house jobs, complicating the recruitment of temp workers. This second effect always dominates when both temp and in-house jobs are available, to the extent that it is easy to redirect search efforts between temp and in-house jobs, a feature well accounted for by the directed search model. It is worth noting that the scarcity of temp jobs in decentralized equilibrium implies that there are parameter set values where firms employ only in-house workers, even though it would be more efficient to use both temp and in-house workers.

Proposition 4 reveals that the number and share of in-house jobs remain always too high in decentralized equilibrium compared with the constrained efficient allocation across all parameter set. However, a comparison between the constrained efficient solution and the decentralized equilibrium shows differences in the number of temp jobs and the total number of jobs, which depend on specific parameter values. Specifically, the decentralized equilibrium either has too many or too few temp jobs when it includes both job types. Consequently, when the decentralized equilibrium includes both temp and in-house jobs, the total number of jobs can be either excessively high or insufficiently low. In contrast, scenarios where the decentralized equilibrium includes only temp jobs consistently show an oversupply of these positions. This excess occurs because workers lack alternative in-house job options, forcing them to accept temp jobs at very low wages – see B.4. Model calibration will be used to assess the empirical relevance of these findings.

4.4.3 Implementation of the constrained efficient allocation

The inefficient wage gap between in-house and temp workers induces firms to post too many temp job vacancies and job seekers to search too little for temp jobs. Therefore, it is possible to implement the constrained efficient allocation with wage subsidies for temp workers and taxes on the vacancies posted by the TWAs. Let σ_a denotes the wage subsidy, such that temp workers get the income $w_a + \sigma_a$ when the TWAs pay the wage w_a, and τ_a the tax on each vacancy posted by the TWAs.

Proposition 5. *The constrained efficient allocation is implemented with wage subsidies*

$$\sigma_a = \frac{r+q}{\alpha m(\theta_a^*)} rk$$

for temp workers financed by a tax $\tau_a = rk$ on the vacancies posted by TWAs.

Proof. See appendix B.6 □

When the constrained efficient allocation is implemented, the labor income gap between in-house and temp workers is equal to

$$w_h - (w_a + \sigma_a) = \eta(c_a - c_h)$$

Thus, we can claim:

Proposition 6. *When the constrained efficient allocation is implemented with subsidies and taxes in the decentralized equilibrium, the wage gap between in-house workers and external workers only depends on the gap between the costs of human resources management of TWAs for temp workers and firms for in-house workers.*

5 Quantitative analysis

This section begins by describing the decomposition of the wage gap by distinguishing between efficient and inefficient components. It then presents the calibration of the model. This calibration is used to evaluate the welfare gap between the constrained efficient allocation and the decentralized equilibrium. It is also used to quantify the impact of TWAs activity on welfare and employment.

5.1 Wage gap

Figure A.1.4 reports the distribution of the average daily wage by markets, respectively for TWA and in-house workers. In the model, the wage gap can be defined both in the decentralized equilibrium and after the implementation of the social optimum (efficient wage gap) as presented in equation (18):

$$\underbrace{w_h - w_a}_{\text{Wage gap in decentralized equilibrium}} = \underbrace{\eta(c_a - c_h)}_{\text{Efficient wage gap}} + \underbrace{\eta(r+q)\frac{rk}{\alpha m(\theta_a)}}_{\text{Inefficiency}}. \tag{18}$$

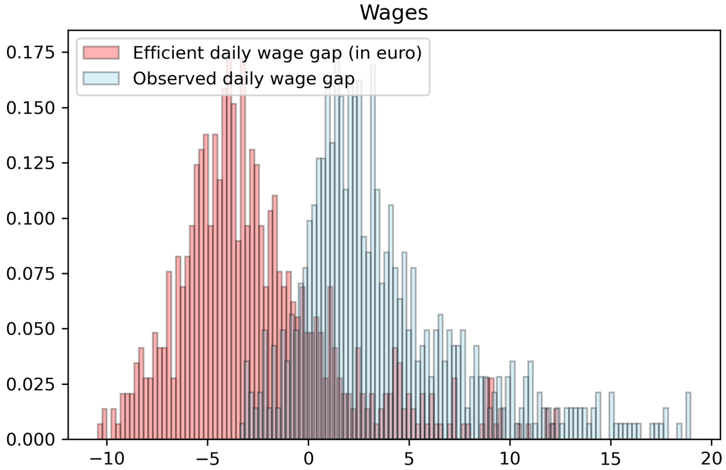
Before moving to a full calibration of the model market by market, we can simply use direct observations on the separation rate q, the job filling rate of TWA workers $\alpha m(\theta_a)$ and the stock of capital k and set the values of η and r to evaluate the size of the inefficiency (see next Section for details on the data). Figure V reports the distribution of both the theoretical wage gap $w_h - w_a$ and the efficient wage gap defined as the difference between the decentralized wage gap and the inefficiency presented in equation (18).

The distribution of efficient wage gaps is translated to the left compared to the distribution of the theoretical wage gaps and the magnitude of the inefficiency is around 10 euros per day for the average market. Figure VI shows that the share of TWA markdown in the wages of temp workers varies from about 1% to 16% across labor markets, with an average equal to 6.4%.

5.2 Calibration of the model

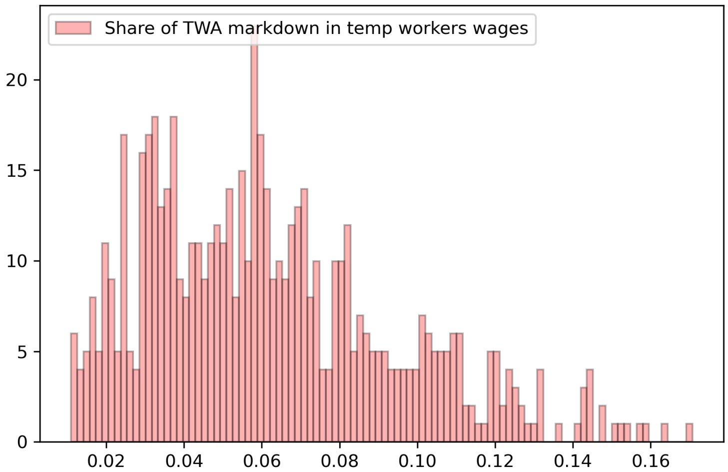
We now turn to a full calibration of the model. To do so, we gather information on each labor market. As explained in Section 2, we define a labor market as a combination of a commuting zone (306 different "zones d'emploi") and a worker skill

FIGURE V. Efficient and actual wage gaps



Notes: Wage gaps are taken as the difference between the average wage of in-house temporary workers and TWA workers for each market and are given in euros per day. Decentralized wage gap corresponds to the "theoretical wage gap" presented in equation (18). Number of observations: 649 labor markets.

FIGURE VI. Share of TWA markdown in temp workers wages



Notes: The share of TWA markdown in temp workers wages if equal to the inefficient term in the right-hand side of equation (18) divided by the wage of temp workers. Number of observations: 649 labor markets.

category. We use the 4^{th} character of the FAP ("FAmilles Professionnelles") classification which split workers into 5 categories once we exclude the executives and most skilled occupations. In what follows, labor markets are indexed by i. We restrict attention to labor markets where we observed at least one worker in both segments (in-house and TWA).

Data In addition to the administrative data on payroll and on the firm balance sheets that we presented in Sections 2 and 3, we use data from the French public employment agency ("*Pole Emploi*") and from the fichier ForCE ("*Formation, Chomage, Emploi*") for the year 2019. These datasets allow us to measure the corresponding job filling rates $\chi_{h,i}$ and $\chi_{a,i}$ and total unemployment $\mathcal{U}_i$.

Cleaning and variable construction We use historic public employment services records available in the ForCE dataset to construct the employment and unemployment histories for the universe of French job seekers. Within each job seeker's unemployment history we concatenate spells whose ending and starting date are separated by less than 30 days. After a basic cleaning step where we ensure that all observations have non-missing information on crucial variables (most notably, age, gender, location and search occupation), we drop all job seekers who declare not to be immediately available for a job in the public employment services' files. All retained job seekers are thus either looking for a full-time permanent position, a permanent part-time position or a regular fixed term duration/temporary work agency job. To construct a measure of local unemployment and job finding rates, we first measure the monthly stock of job seekers observed within each labor market. We average this monthly measure of the stock of registered job seekers over 2019. In a second step we use related exhaustive contract level DSN data ("Déclarations Sociales Nominatives") from the same ForCE datatset to construct the average monthly flow of new contracts in these same commuting zone $\times$ occupation cells. While doing so we restrict to in-house fixed-term contracts (CDD) and TWA type contracts (Interim). Combining the average monthly stocks of registered job seekers and the average monthly flows of new contracts pertaining to the same underlying population of job seekers we are able to construct monthly local labor market level job finding rates by contract type from the flow equilibrium between entries and exits for each contracts type. We add to this information exhaustive information on vacancies posted by firms on public employment services' website. Each vacancy contains information on the location, user firm identifier, contract type, posting firm identifier in the case of temporary work arrangement, occupation, as well as the creation and destruction rate. We use vacancy duration at the occupation, commuting zone and contract type level to construct measures of local job filling rates. Finally we use exhaustive data on employment (DADS Postes) to measure average monthly employment by labor market as well as the share of TWA jobs.

Common parameters. We set two parameters which are common across labor markets. First the elasticity η of the matching function is set to 0.5 which is a standard value used in the literature (Petrongolo and Pissarides, 2001). Second, the real interest rate r is set to 0.01337% to match a daily value corresponding to a yearly interest rate of 5%.

Market specific inputs In addition to the finding rates for both type of workers and the total number of unemployed workers ($\chi_{h,i}$, $\chi_{a,i}$ and u_i) we use market specific values for c_{hi}, y_i, k_i, q_i, $\mathcal{L}_{h,i}$ and $\mathcal{L}_{a,i}$. Details are given in Table VI.

TABLE VI. Market specific inputs

Variable	Description	Source	Average
c_h	HR wagebill per worker (in euro per day)	DADS	14.1
y	Value added of a worker (in euro per day)	FARE and DADS	355
k	Stock of capital per worker (in euro)	DARE and DADS	$22/r$
$\mathcal{L}_h$	Total employment (full time equivalent) of in house workers	DADS	284
$\mathcal{L}_a$	Total employment (full time equivalent) of in TWA workers	DADS	199
q	Inverse of the average duration of a contract in days	DADS	0.0197 (51 days)

y and k cannot be directly measured at the labor market level. We estimate their values at the firm level, respectively, by considering the total value added and the stock of net capital, both divided by the total working time in hours. We then assign these values to each worker in the firm and average for all workers in a given labor market, and convert them into euros per day. q is estimated by taking the inverse of the average contract duration in days, and $\mathcal{L}_h$ and $\mathcal{L}_a$ are measured in full-time equivalent workers.

c_h measures the management cost of an in-house contract, which we proxy by the total wage bill of HR by firm divided by the number of hours worked by in-house workers. We then use the same strategy as the one used for y and k to allocate this value by labor market.

We finally set b, the unemployment benefit to be equal to half of the value of $y - rk$ in the corresponding market. Assuming a labor share of about 0.7, this implies an unemployment benefit equal to roughly 70% of the wage.

Calibration of other parameters We make two functional form assumptions. First, we assume a matching function that can be written for each market i as

$$m(\theta) = m_{0i}\theta_i^{-\eta}$$

where m_0 is a parameter that can vary by market. Second, we assume that the vacancy cost function for in house workers can be written as:

$$C(\mathcal{V}) = \nu_{0i}\mathcal{V}_i^{\nu},$$

and we thus have $C(\mathcal{V}_i)' = \nu_{0i}\nu\mathcal{V}_i^{\nu-1}$. Similarly to the matching function, we assume that the exponent parameter ν is similar across markets while the scale parameter ν_0 is market specific.

Objective function From our data, we observe:

$$\Theta_i = (y_i, k_i, b_i, \mathcal{L}_{h,i}, \mathcal{L}_{a,i}, q_{h,i}, q_{a,i}, \chi_{h,i}, \chi_{a,i}, \mathcal{U}_i, c_{h,i})$$

We also have imperfect measures of the job finding rates from looking at the average duration in unemployment by market respectively for individuals seeking a job as in-house workers or through a TWA. We denote these rates as $\varphi_{h,i}, \varphi_{a,i}$ and we allow them to be measured with some error so that the observed value are denoted $\tilde{\varphi}_{h,i}$ and $\tilde{\varphi}_{a,i}$. This is because we do not observe in which segment an unemployed worker is really searching for a job. Finally, we measure the average wage gap (dw_i) from a regression at the individual level where the dependent variable is the wage in level and where we include an interaction between a dummy for working in-house and a labor market fixed effect, similarly to the approach presented in equation (4).

We also set parameters r and η and we want to estimate a vector of model specific parameters:

$$\Gamma_i = (\mathcal{V}_{h,i}, \mathcal{V}_{a,i}, \mathcal{U}_{h,i}, \mathcal{U}_{a,i}, m_{0i}, \kappa_i, c_{a,i}, \alpha_i, \theta_{h,i}, \theta_{a,i}, p_i)$$

as well as ν_{0i} and ν.

Our strategy is detailed in Appendix C. The general strategy is to solve exactly for the equations defining the decentralized equilibrium while minimizing the distance between the measured wage gap dw_i and the model induced wage gap as defined in equation (15) as well as $\tilde{\varphi}_{h,i}$, $\tilde{\varphi}_{a,i}$.

Results We manage to successfully calibrate the model for 649 markets which represents 639,710 individuals. The average values of each component of Γ is given in Table VII. The values of ν and ν_0 are respectively 1.21 and 26.6. The average value of α is 1.52 which means that TWA are more than 50% more efficient in finding workers, this value is lower than 1 for 13% of the markets.

TABLE VII. Results in decentralized equilibrium

	$\mathcal{V}_{h,i}$	$\mathcal{V}_{a,i}$	$\mathcal{U}_{h,i}$	$\mathcal{U}_{a,i}$	m_{0i}	κ_i	$c_{a,i}$	α_i	$\theta_{h,i}$	$\theta_{a,i}$	p_i
Mean	229	138	297	206	0.021	95.1	9.43	1.52	0.752	0.954	321
p25	28	5	42	9	0.018	44.9	2.95	1.14	0.584	0.655	230
p50	94	25	123	42	0.021	68.8	6.45	1.38	0.723	0.835	305
p75	242	118	300	197	0.023	112.8	12.9	1.70	0.884	1.095	373

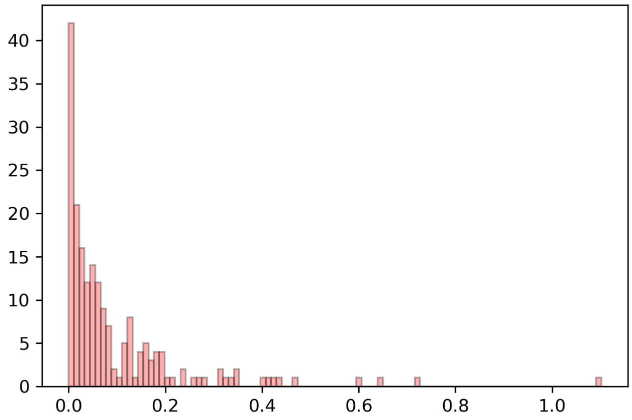
Notes: Average value and first, second and third quartiles of the component of Γ. Averages are unweighted across all 649 markets. $\mathcal{V}_{h,i}$, $\mathcal{V}_{a,i}$, $\mathcal{U}_{h,i}$ and $\mathcal{U}_{a,i}$ are given in number of individuals, κ_i, $c_{a,i}$ and p_i are in euros (per day for $c_{a,i}$ and p_i).

The number of vacancies is large (the size of the average market is 3000 workers), this is consistent with a low duration of contracts for these workers as discussed previously. Consequently, the number of unemployed workers in both the in-house and TWA segment is relatively high. This does not necessarily translate into a large unemployment rate because the time spent in unemployment is usually low. Finally, the average price of a TWA worker for the firm p is on average 1.2 times the value of w_a.

5.3 Comparison of constrained efficient and decentralized allocations

We now use the calibrated values of κ, c_a, m_0, ν, ν_0, and α, as well as the observed values for y, q, k, c, and b from the previous section, to calculate the optimal values of the number of vacancies $\mathcal{V}_h$ and $\mathcal{V}_a$, the labor market tightnesses θ_h and θ_a, the share of temp worker γ, and employment $\mathcal{L}$ for each market as defined by equations (17). One important difference with the decentralized equilibrium is that we need to consider two equilibrium types since we have shown that it is possible that the constrained efficient allocation has temp workers only when the decentralized equilibrium has both in-house and temp workers—as detailed in Appendix B.4.4. The process is further

FIGURE VII. Distribution of variation in welfare (in %) between the constrained efficient allocation and decentralized equilibrium



Notes: This figure is the histogram of the variation in total production minus the cost of vacancies and capital between the constrained efficient solution and the decentralized equilibrium across labor markets.

elaborated in Appendix C.2. We start by showing the difference in aggregate welfare between the constrained efficient and decentralized allocations across markets before highlighting the differences in the number of job seekers, vacancies, and jobs in temp and in-house job markets. Subsequently, we analyze the effects of several policies: taxes and subsidies employed to enact the constrained efficient allocation, the elimination of the wage gap, and the prohibition of TWAs.

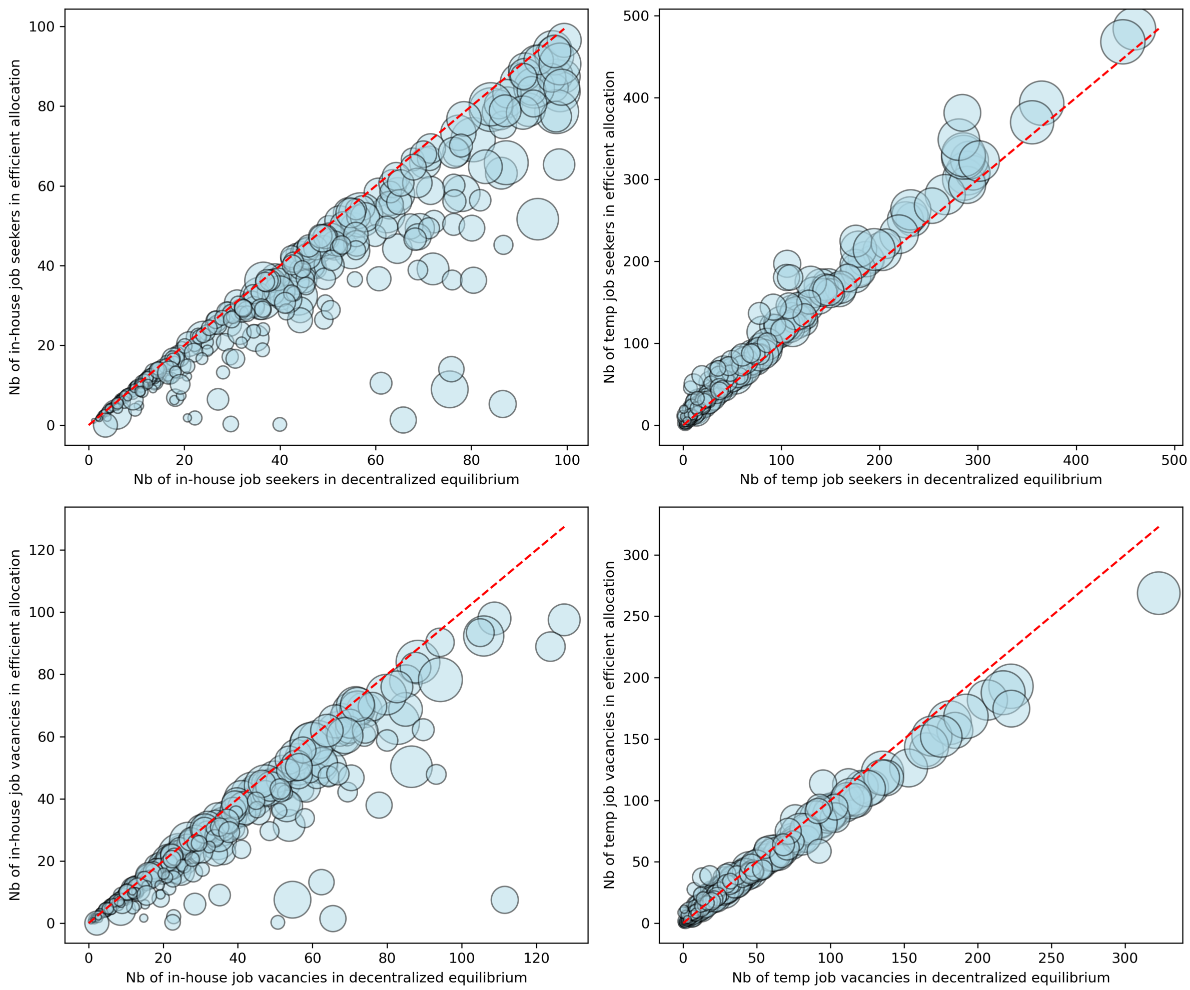
5.3.1 Welfare

According to Figure VII, welfare – measured as total production minus the costs of vacancies and capital —- is typically about 0.1% higher in the constrained efficient allocation than in the decentralized equilibrium. Relatively, this welfare difference is smaller than the markdown in temporary workers' wages due to TWA, equal to about 6%, which drives the inefficiency in the decentralized equilibrium. The reason is that job seekers can direct their search towards in-house jobs at no cost in the directed search model.

5.3.2 Job seekers and vacancies

In all markets, the constrained efficient allocation results in more unemployed workers seeking temporary jobs and fewer seeking in-house positions compared to the

FIGURE VIII. Job seekers and vacant jobs in constrained efficient allocation and in decentralized equilibrium



Notes: Each dot represents a labor market. The size of the dot is proportional to the size of the market (total number of employed and unemployed workers). The red line corresponds to the 45 degree lines.

decentralized equilibrium – see top panels of Figure VIII. This disparity stems from the decentralized equilibrium's inefficiency, which arises due to fewer job seekers pursuing temporary positions because of lower wages offered by TWAs. Additionally, there are fewer in-house job vacancies under the constrained efficient allocation – see bottom left panel of Figure VIII. Although more job seekers opt for temporary positions in the constrained efficient allocation, the availability of these vacancies may be lower than in the decentralized equilibrium. This discrepancy is due to firms being incentivized to post too many temp job vacancies in the decentralized equilibrium, influenced by the relatively low wages paid to temp workers – see bottom right panel of Figure VIII.

5.3.3 Number of in-house and temp jobs

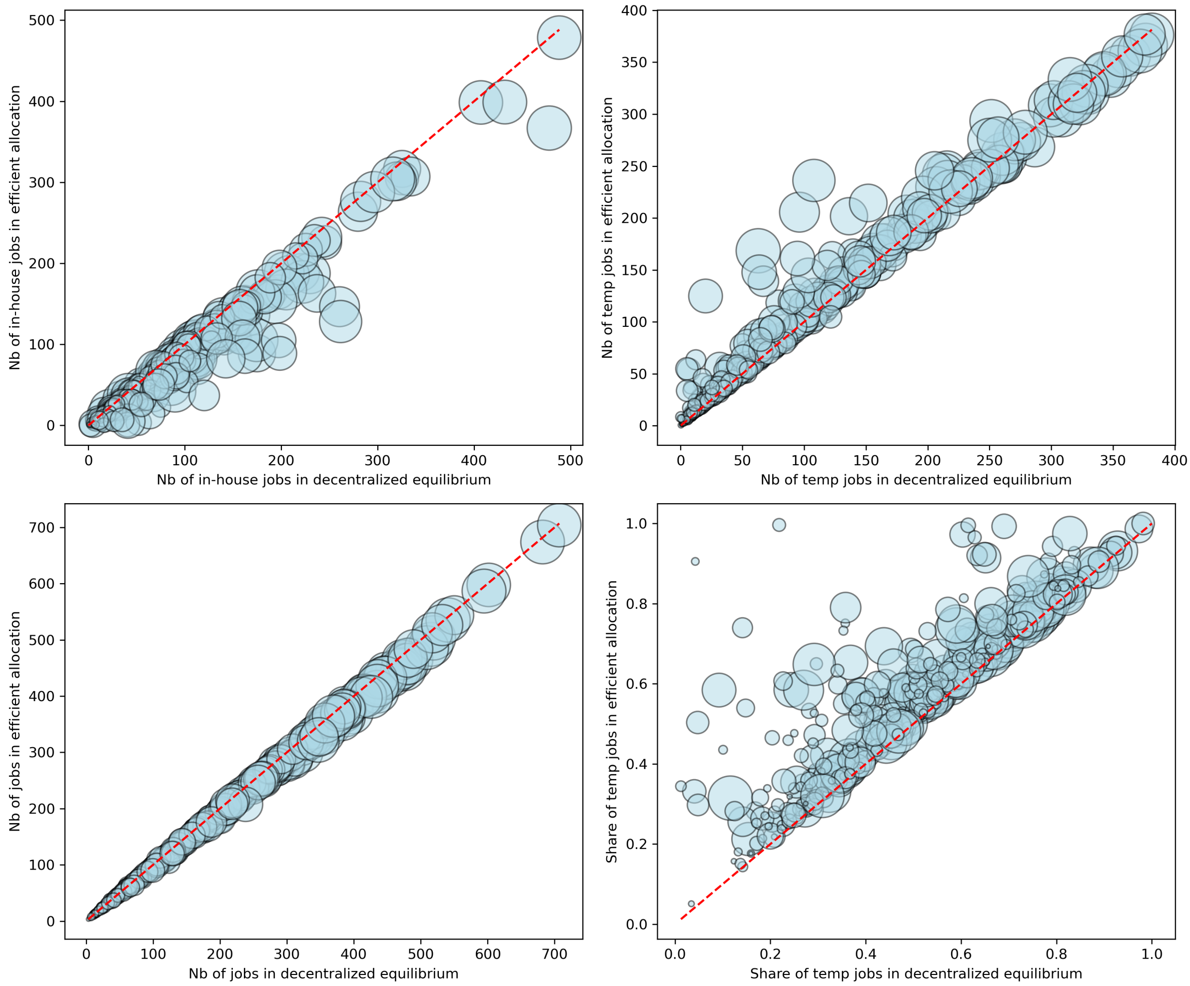
The excess of job seekers looking for in-house jobs and of in-house job vacancies in the decentralized equilibrium induces too many in-house jobs – see Figure IX, top left panel. The number of temp jobs is lower in the decentralized equilibrium in about one fourth of the markets – top right panel – but the share of temp jobs in the total number of jobs is always lower in the decentralized equilibrium – bottom right panel.

Since TWAs have lower human resource management costs and a more efficient matching technology than user firms, corresponding to a value of α greater than one in most markets – see Table VII –, could suggest that the larger share of TWA jobs in the constrained efficient allocation would entail more jobs overall. However, as shown in the bottom left panel of Figure IX, this is not the case in 99% of the markets. The markdown in the wages of temp workers prompts firms to create too many temp jobs relative to the number of job seekers, resulting in excessive labor market tightness for temp jobs in the decentralized equilibrium. Additionally, an excess of job seekers for in-house positions leads to the over-creation of those jobs. Therefore, despite the larger share of temp jobs in the constrained efficient allocation and the lower human resources management costs and more efficient matching technologies of TWAs, the inefficiency of the decentralized equilibrium does not necessarily result in a lower number of jobs than in the constrained efficient allocation. Actually, the total number of jobs if 4% lower in the constrained efficient allocation.

5.3.4 Wage subsidies and discounted expected incomes

The constrained efficient allocation involves implementing a wage subsidy for temp workers, averaging about 4.6% of their wage. This subsidy ranges from approximately 0.2% to 15% across different labor markets —- see Figure X, top right panel. In the constrained efficient allocation, the improved allocation of job seekers and vacancies leads to an average increase of about 0.2% in the discounted expected income of unemployed workers, varying from 0.01% to 1.3% across markets —- top left panel. This very small effect results two opposing effects. On the one hand, there is a significant hike in the discounted expected income of temp workers, which equals 14.7% on average and ranges from 1.9% to 49.9%. On the other hand, a slight decrease of 0.5% on average in the discounted expected income of in-house workers. These changes in discounted expected income are compensated by changes in the expected duration of unemployment of job seekers looking for temp jobs, which increases when the sub-

FIGURE IX. Unemployment and employment in constrained efficient allocation and in decentralized equilibrium



Notes: Each dot represents a labor market. The size of the dot is proportional to the size of the market (total number of employed and unemployed workers). The red line corresponds to the 45 degree lines.

sidy is introduced, and that of those looking for in-house jobs, whose unemployment duration drops.

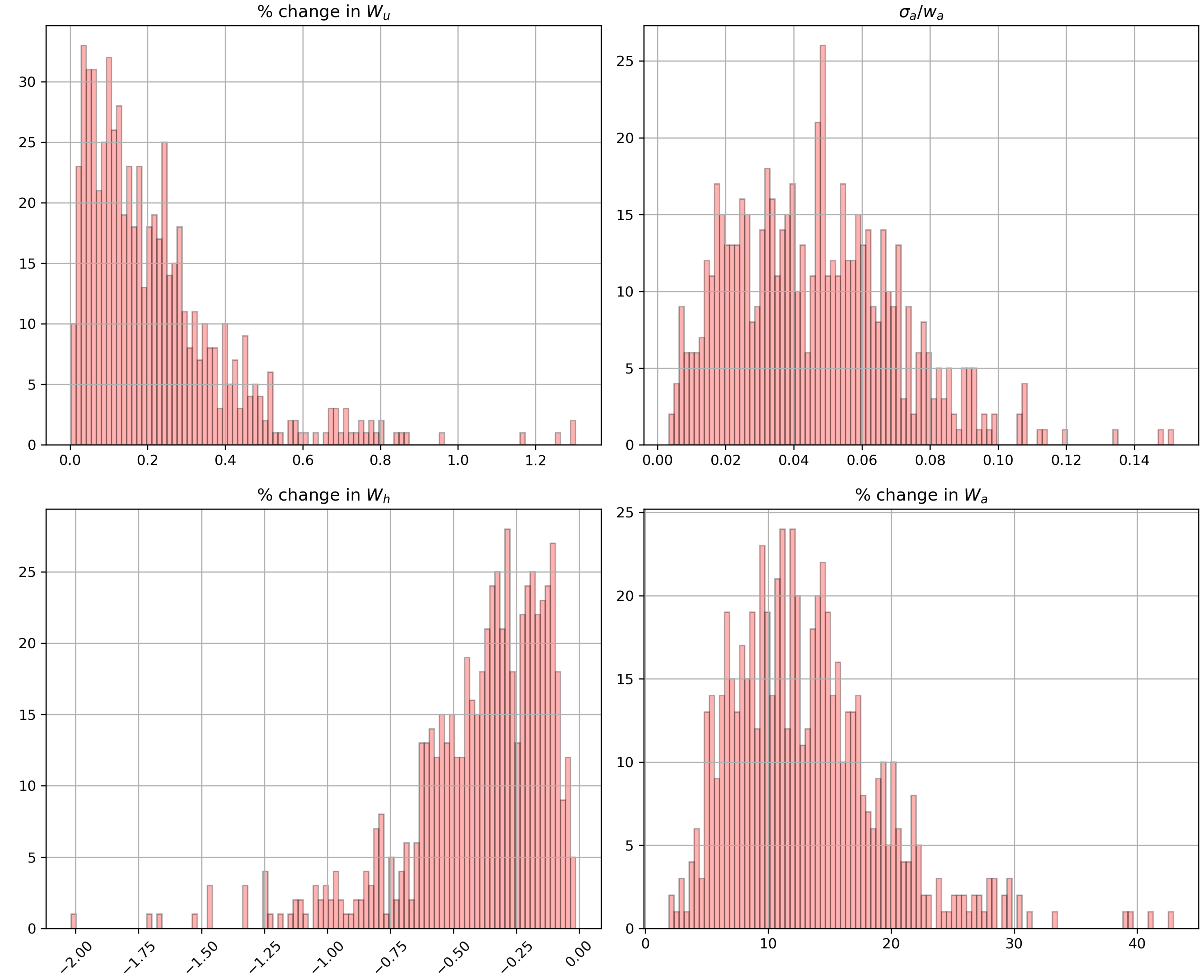
5.4 Eliminating the wage gap

Insofar as the decentralized equilibrium is inefficient and this inefficiency is associated with reduced wages for temp workers, eliminating the wage gap might improve welfare. This would alter the labor market equilibrium as follows (see Appendix B.7): If the wage of temp workers is lower than that of in-house workers, temp employment would become unprofitable for agencies, implying that only in-house jobs would exist. Conversely, if temp employment pays more, in-house jobs would disappear. Figure XI illustrates the relationship between the wage gap and the welfare gains associated with eliminating the wage gap across labor markets. There are gains when the wage gap is negative and losses otherwise. On average, the effect is negative, resulting in a welfare loss of about 0.3%. Employment variation, however, is consistently negative, showing a decrease of 6.2% in total employment.

5.5 Welfare and employment gains from TWAs

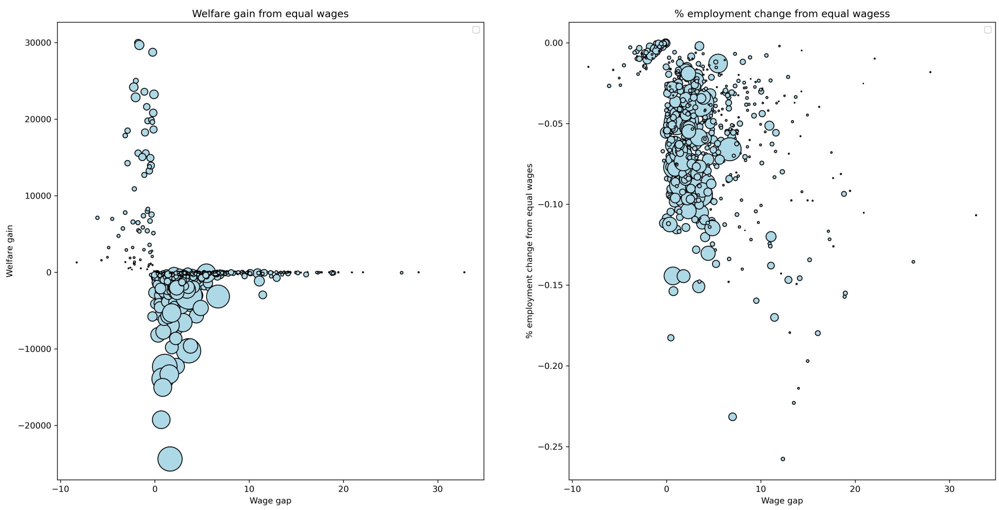
So far, we have examined the consequences of introducing subsidies and taxes aimed at improving the functioning of the labor market in the presence of TWAs and of eliminating the wage gap. A related question concerns the implications of banning or limiting temp jobs, as excessive use of temp workers can diminish welfare in the decentralized equilibrium. To address this issue, we compare the decentralized equilibrium scenarios with and without TWAs to evaluate the effects of a complete ban of these intermediaries (Figure XII). Our analysis reveals that TWAs contribute to total welfare, increasing it by an average of 0.6%. Welfare gains vary from -0.1% to 2.4% across labor markets. The impact of TWAs on welfare is negative in three markets where TWAs incur significantly higher human resource management costs compared to user firms, yet possess highly efficient matching technology, facilitating temporary job creation despite the associated costs. TWAs raise the discounted expected income of unemployed workers across all markets, ranging from 0.02% to 3.8%, with an average increase of 1.4%. TWAs also boost employment by 6.4%, though this figure ranges from -0.12% to 25.8%. Notably, their impact on employment is negative in only one market, characterized by low matching efficiency and low human resource management costs for TWAs.

FIGURE X. Disparities in wage subsidies and variations in discounted income expectations and wages across markets



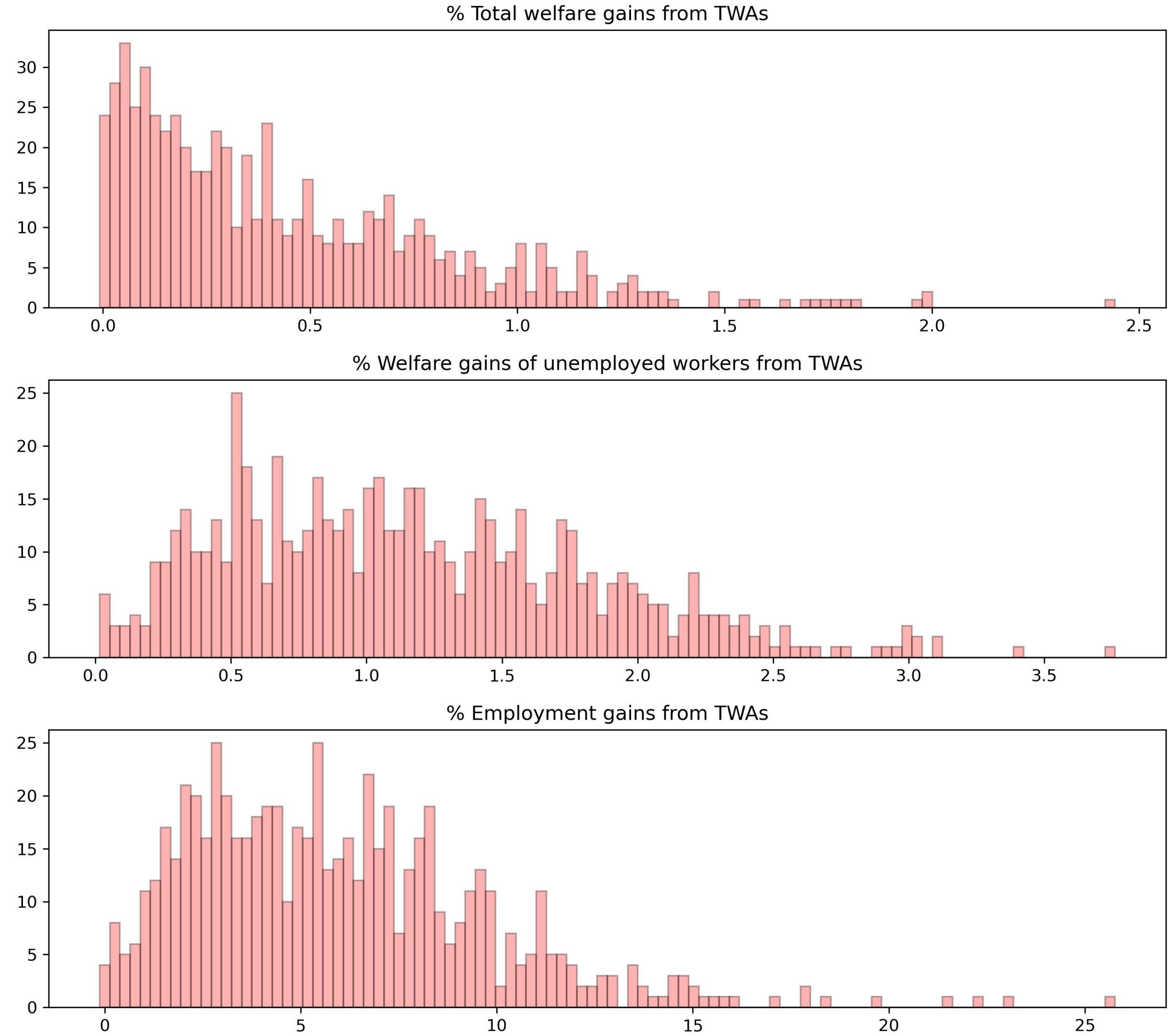
Notes: The figure illustrates disparities in wage subsidies and variations in discounted income expectations across markets between the constrained efficient allocation and the decentralized equilibrium across labor markets. Top right: Histogram showing the wage subsidy to temp workers divided by their wage. Top left: Percentage variation in the discounted expected income of unemployed workers between constrained efficient allocation and decentralized equilibrium. Bottom right: Percentage variation in the discounted expected income of temp workers between constrained efficient allocation and decentralized equilibrium. Bottom left: Percentage variation in the discounted expected income of in-house workers between constrained efficient allocation and decentralized equilibrium.

FIGURE XI. Welfare and employment gains from eliminating the wage gap



Notes: The figure illustrates the relation, across labor markets, between the wage gap in favor of in-house workers (horizontal axis on both panels) and the welfare (left panel) and employment (right panel) gains associated with eliminating the wage gap. Each dot represents a labor market. The size of the dot is proportional to the size of the market (total number of employed and unemployed workers).

FIGURE XII. Welfare and employment gains from TWAs



Notes: The figure illustrates disparities the welfare gains equal to the discounted total production minus the discounted cost of vacant jobs (top panel), the discounted expected incomes of unemployed workers (middle panel) and employment gains (bottom panel) from the TWAs activity in the decentralized equilibrium across labor markets.

6 Conclusion

This article shows that the wage gap between in-house workers and temp workers holding identical positions, averaging 3% in favor of in-house workers, is nevertheless negative in about a quarter of cases. The analysis of this wage gap shows that it contains an efficient component, resulting from differences in the management costs of temp workers and in-house workers, and an inefficient component, stemming from the cost of maintaining vacant positions by user firms. This cost, which reduces the price paid by user firms to TWAs for employing temp workers, lowers the wages of temp workers by an average of 6% according to our estimates. However, the assessment of the impact of this inefficiency on welfare suggests that it leads to a minor loss, typically around 0.1% across all local markets, due to the possibility for unemployed individuals to choose between temp and in-house job offers. Furthermore, despite this inefficiency, the activity of TWAs improves welfare by approximately 1.4% on average, with a positive impact in almost all local markets. Moreover, eliminating the wage gap has a slight negative impact on total welfare and a significant negative effect on employment, which drops by about 6%.

These results are situated within a framework where TWAs enable companies to recruit labor more quickly and to outsource the cost of human resource management. These are two essential components of the TWA activity. However, they overlook the fact that TWAs can improve the quality of matches between jobs and workers. Empirical assessment of this dimension of the TWA activity and its consequences requires the use of an analytical framework that integrates the heterogeneity of workers and jobs, which will need to be addressed in future work to refine our conclusions and assess their robustness.

References

Abowd, John M, Francis Kramarz, and David N Margolis, "High wage workers and high wage firms," *Econometrica*, 1999, *67* (2), 251–333.

Acemoglu, Daron and Robert Shimer, "Holdups and efficiency with search frictions," *International Economic Review*, 1999, *40* (4), 827–849.

Atencio-De-Leon, Andrea, Chen Yeh, and Claudia Macaluso, "Job Dynamics with Staffed Labor," *Richmond Fed mimeo*, 2024.

Autor, David H., "Why Do Temporary Help Firms Provide Free General Skills Training?," *The Quarterly Journal of Economics*, 2001, *116* (4), 1409–1448.

_ **and Susan N. Houseman**, "Do Temporary-Help Jobs Improve Labor Market Outcomes for Low-Skilled Workers? Evidence from "Work First"," *American Economic Journal: Applied Economics*, July 2010, *2* (3), 96–128.

Babet, Damien, Olivier Godechot, and Marco G Palladino, "In the Land of AKM: Explaining the Dynamics of Wage Inequality in France," 2022. Mimeo Sciences Po.

Beneito, Pilar, Maria Garcia-Vega, Oscar Vicente-Chirivella, and Guillaume Wilemme, "Robots and firms' labour search: The role of temporary work agencies," Technical Report 2024.

Biglaiser, Gary and Fei Li, "Middlemen: the good, the bad, and the ugly," *The RAND Journal of Economics*, 2018, *49* (1), 3–22.

Bilal, Adrien and Hugo Lhuillier, "Outsourcing, Inequality and Aggregate Output," Working Paper 29348, National Bureau of Economic Research October 2021.

Bonhomme, Stéphane, Thibaut Lamadon, and Elena Manresa, "A distributional framework for matched employer employee data," *Econometrica*, 2019, *87* (3), 699–739.

Carrasco, Raquel, Ismael Gálvez-Iniesta, and Belén Jerez, "Do temporary help agencies help? Employment transitions for low-skilled workers," *Labour Economics*, 2024, p. 102586.

Coşar, A. Kerem, Nezih Guner, and James Tybout, "Firm Dynamics, Job Turnover, and Wage Distributions in an Open Economy," *American Economic Review*, March 2016, *106* (3), 625–63.

Drenik, Andres, Simon Jäger, Pascuel Plotkin, and Benjamin Schoefer, "Paying outsourced labor: Direct evidence from linked temp agency-worker-client data," *The Review of Economics and Statistics*, 2020, pp. 1–28.

Gautier, Pieter, Bo Hu, and Makoto Watanabe, "Marketmaking Middlemen," *The RAND Journal of Economics*, 2023, *54* (1), 83–103.

Gavazza, Alessandro, Simon Mongey, and Giovanni L. Violante, "Aggregate Recruiting Intensity," *American Economic Review*, August 2018, *108* (8), 2088–2127.

Goldschmidt, Deborah and Johannes F Schmieder, "The rise of domestic outsourcing and the evolution of the German wage structure," *Quarterly Journal of Economics*, 2017, *132* (3), 1165–1217.

Jahn, Elke and Enzo Weber, "The effect of temporary help jobs on employment volatility," *Canadian Journal of Economics/Revue canadienne d'économique*, 2016, *49* (1), 412–427.

Kircher, Philipp, "Job Search in the 21St Century," *Journal of the European Economic Association*, 10 2022, *20* (6), 2317–2352.

Kline, Patrick, Raffaele Saggio, and Mikkel Sølvsten, "Leave-out estimation of variance components," *Econometrica*, 2020, *88* (5), 1859–1898.

Manning, Alan, "A Generalised Model of Monopsony," *The Economic Journal*, 2006, *116* (508), 84–100.

Masters, Adrian, "Middlemen in Search Equilibrium," *International Economic Review*, 2007, *48* (1), 343–362.

Merz, Monika and Eran Yashiv, "Labor and the Market Value of the Firm," *American Economic Review*, September 2007, *97* (4), 1419–1431.

Moen, Espen R, "Competitive Search Equilibrium," *Journal of Political Economy*, 1997, *105* (2), 385–411.

Neugart, Michael and Donald Storrie, "The emergence of temporary work agencies," *Oxford Economic Papers*, 2006, *58* (1), 137–156.

OECD, *OECD Employment Outlook 2021* 2021.

Petrongolo, Barbara and Christopher A. Pissarides, "Looking into the Black Box: A Survey of the Matching Function," *Journal of Economic Literature*, June 2001, *39* (2), 390–431.

Rubinstein, Ariel and Asher Wolinsky, "Middlemen," *The Quarterly Journal of Economics*, 1987, *102* (3), 581–594.

Watanabe, Makoto, "Middlemen: A Directed Search Equilibrium Approach," *The B.E. Journal of Macroeconomics*, 2020, *20* (2), 20190258.

Weill, Pierre-Olivier, "The Search Theory of Over-the-Counter Markets," *Annual Review of Economics*, 2020, *12* (1), 747–773.

Wright, Randall, Philipp Kircher, Benoît Julien, and Veronica Guerrieri, "Directed Search and Competitive Search Equilibrium: A Guided Tour," *Journal of Economic Literature*, March 2021, *59* (1), 90–148.

Yavaş, Abdullah, "Middlemen in Bilateral Search Markets," *Journal of Labor Economics*, 1994, *12* (3), 406–429.

Online Appendix

Table of contents

A Empirical Appendix **OA-1**

A.1 TWA workers across labor markets OA-1

A.2 Data Construction OA-2

A.3 Robustness and additional results AKM Analysis OA-6

B Model Appendix **OA-14**

B.1 Value functions and offered wages OA-14

B.2 Labor market equilibrium OA-16

B.3 Constrained efficient solution OA-19

B.4 Comparison of the decentralized equilibrium with the constrained efficient solution OA-22

B.5 Decentralized equilibrium with merged TWAs and user firms OA-25

B.6 Implementation of the constrained efficient allocation OA-27

B.7 Equal wages OA-28

C Details on the quantitative calibration **OA-30**

C.1 Calibration of the decentralized equilibrium from the data OA-30

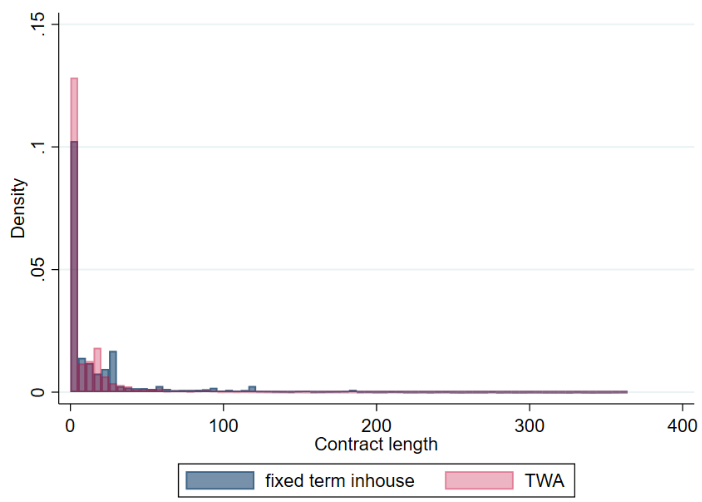
C.2 Quantification of the social optimum OA-31

A Empirical Appendix

A.1 TWA workers across labor markets

Figure A.1.1 shows the distribution of the length of all fixed-term contracts signed in 2019 in the private sector measured with the DMMO component of the FORCE database. The advantage of this data, relative to the DADS used in the main analysis, is that it reports all distinct contracts signed between workers and employers, even when they only last one day and even when they are rolled-over several times. In the latter case, each renewal is counted as a new contract. One caveat of the FORCE database is that it restricts the sample to workers that have been registered at least once with the French unemployment services *Pôle Emploi*. However, given the short nature of most fixed term contracts, we do not expect to lose many workers due to this restriction. Another caveat is that it does not report the number of hours worked, making it impossible to translate the length in terms of full time equivalents. Figure A.1.1 distinguishes between the length of in-house contracts (CDD) and TWA contracts. The median (mean) length of in-house fixed-term contracts is 3 days (14 days), while for TWA contracts it is 4 days (10 days). We can also see that about 25% of in-house fixed-term contracts and 23% of TWA contracts last only one day. The fact that the contract length is much shorter in the DMMO than in the DADS suggests that most of these very short contracts are rolled-over several times within the same TWA. Furthermore, even when looking at every contract separately, we find that in-house fixed term contracts are of similar length than TWA contracts, making these two employment arrangements very comparable.

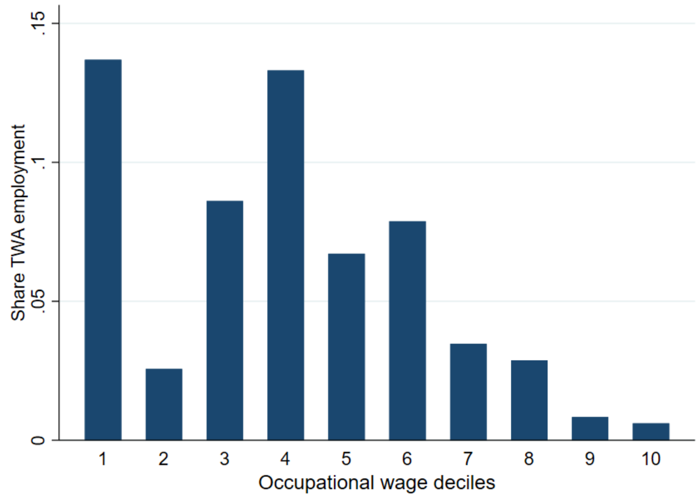
FIGURE A.1.1. Distribution of contract length



Notes: The graph is constructed using the *DMMO data*, which records all the single contracts signed in a given year, while the DADS aggregates them. It shows the distribution of the length of all fixed-term contracts signed in 2019, and disentangles between in-house (CDD) and TWA contracts.

Figure A.1.2 shows the distribution of the share of TWA employment expressed in full time equivalent across occupations grouped in deciles according to their average wage level measured across all contract types. While low paying occupations are clearly more concerned by TWA employment, we do observe non-negligible shares of TWA employment up until the 7th decile of wage levels, highlighting the widespread nature of this type of contracts.

FIGURE A.1.2. Share of TWA employment by occupational wage decile



Notes: The graph plots the share of TWA workers, expressed in full time equivalent, across occupations binned in deciles according to their average wage level (measured across all contract types).

Figure A.1.3a reports the share of TWA workers over total temporary work contracts (both in house and TWA). We see that there exists some degree of heterogeneity across CZ, however this variance is much lower than across occupation. Considering the 21,307 pairs with at least one temporary contracts[19] we find that an occupation fixed effect explains 42.5% of the variance while a CZ fixed effect only explains 6.4%.

Figure A.1.3b shows that the relative wage gap - the difference between the average hourly wage of a TWA worker and the average hourly wage of an in-house temporary worker - is also heterogeneous across CZ and is negative for 40% of them. If we consider individual markets, we find a negative wage gap in a little less than half of the cases. Figure A.1.4 plots the entire distribution of wages for fixed-term in-house and TWA workers. These distributions reports the unconditional average wages which do not take into account the fact that TWA and in-house workers can be different and work in different occupations and firms. We see that fixed-term in-house workers are more concentrated at the bottom of the distribution, close to the minimum wage, but also at the top, while TWA wages are more concentrated in the middle. The median (mean) wage of fixed-term in-house is 12.5 euros (13.9), while for TWA workers is 12.8 (13.7). In Section 3, we investigate further this wage heterogeneity.

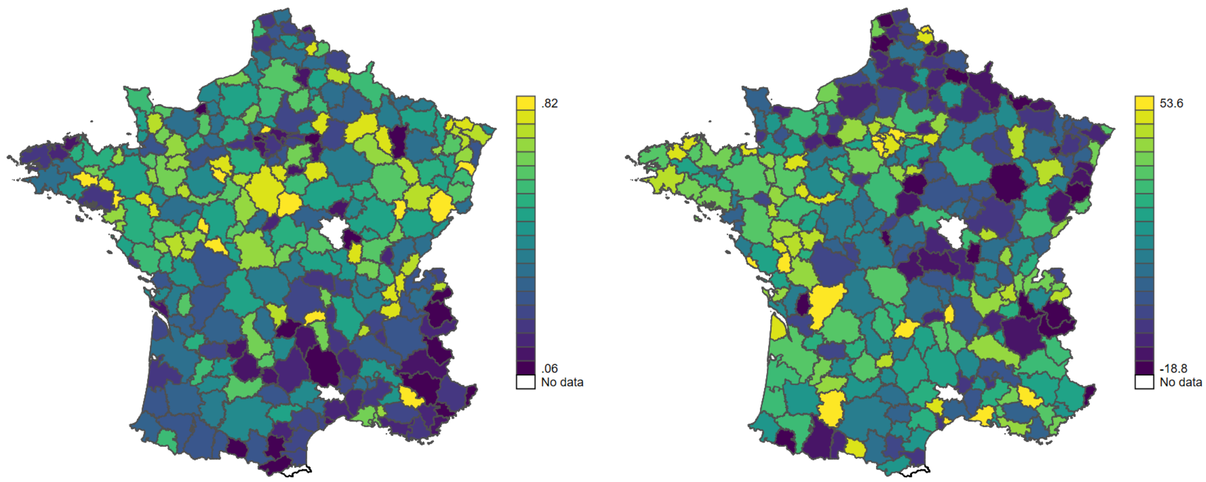
A.2 Data Construction

The most commonly used French administrative employer-employee data is derived from the payroll tax registry called *DADS postes*. In this dataset, firms and their establishments have consistent identifiers across all yearly waves, and can thus be followed over time. On the other hand, workers have anonymized identifiers that connect them to the different jobs that they perform in a given yearly wave, but are changed from one wave to the next precluding the possibility of following workers over a longer period of time. The original work by Abowd

[19]There are 84 occupations and 297 CZ which in theory amount to 24,948 possible pairs but some occupations are non-existent in some CZ.

FIGURE A.1.3. Geographical distribution of TWA contracts and wage gap

(a) Share of TWA workers (b) Relative wage gap (%)



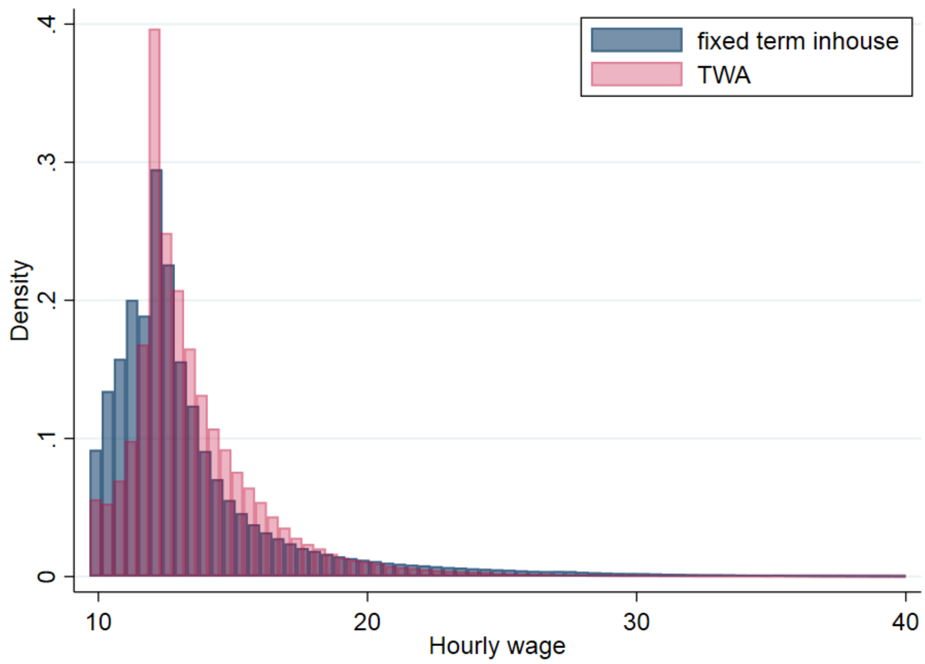
Notes: TWA workers are located using the establishment in which they work (as opposed to the TWA that employ them). The share is calculated using total number of hours worked over all temporary workers (CDD and TWA). The wage gap is calculated as the relative difference between the average hourly wage of TWA workers and the average hourly wage of CDD workers in each CZ. Average 2017-2019.

et al. (1999), as well as most papers using individual panel data from France, rely on the narrower *DADS panel*. The latter is provided by the French statistical office INSEE and consists in a sub-sample of 1/12th of the French workforce, selected based on their month of birth, that is complemented with individual identifiers that are consistent across years.[20] This dataset is not optimal for performing AKM-type regressions, because it amplifies the issue of the limited connected set.

Nevertheless, each yearly file of the full *DADS postes* contains some information related to the previous year (t-1). In particular, for each job post present in a given year t, we know whether the same individual was already working for the firm the year before, and in that case we know the occupation, the wage, the number of hours worked, the municipality of work and residence, etc. Even for individuals that were working in a different firm at time t-1, we still find the information relative to t-1 in the yearly wave of t, only with missing values for the variables relative to the present (t). This overlap over consecutive years allows for matching between yearly files, based on the common information inserted in the variables at t for the previous year and the variables at t-1 for the consecutive year. The paper by Babet et al. (2022) shows that such procedure gives a single match to 98% of the individuals. The matching cannot be established in the rare cases were several individuals have the exact same information, or were the information for a given individual were corrected from one wave to the next. Finally, individuals that go through career breaks that last more than one year cannot be connected, so are identified as different individuals if they reappear later on in the data. We follow the codes made available on the authors' website and construct the full panel

[20]Before 2002 the sample only included 1/24th of the entire workforce, and was increased to 1/12th from 2002 onward.

FIGURE A.1.4. Distribution of the wages



Notes: Distribution of average wage per day for in-house temporary workers (CDD) and TWA workers respectively. Average 2017-2019.

for the years 2017-2019, corresponding to the years where we can find information on both the employing firm and establishment and the using firm and establishment for TWA work arrangements.

We perform some additional cleaning on the data. First of all, we exclude the agricultural sector and the public sector, because of the difference in wage setting procedures, and we restrict the sample to firms belonging to the legal category of "commercial companies". We only keep the 3 most important types of contract : open-ended contracts (CDI), fixed-term contracts (CDD), and TWA contracts (interim), to avoid other minor regimes such as apprenticeships and contracts subsidized by the state to reinsert the long-term unemployed. Within CDD, we also drop the "CDD d'usage", because governed by very specific conditions[21]. Once this cleaning is performed, 64% (75%) of in-house fixed-term contracts (TWA contracts) are signed to face temporary growth in the economic activity of firms, and the rest are signed to replace an employee that is temporarily absent (see Table A.2.1). We further restrict to workers aged 18 to 67 active in Metropolitan France, earning an hourly wage equal or above the minimum wage of the preceding year and within the first 99 percentiles (we trim the top percentile), and working between 1 and 14 hours per day.

[21]"CDD d'usage" are fixed-term contracts signed in specific sectors or occupations where open-ended contracts are extremely rare and fixed-term contracts are the norm. 23% of in-house fixed-term contracts are of this sort, while only 1% of Temp agency contracts are concerned by this motive.

TABLE A.2.1. Distribution of motives invoked to justify fixed-term contracts

	In-house temp workers		TWA workers	
	N.	Share	N.	Share
Temporary replacement of an employee	762773	33%	769161	22%
Temporary growth in activity	1470781	64%	2588205	75%
Other motives combined	64111	3%	91462	3%
Total	2297665	100%	3448828	100%

Note: Distribution for 2019, obtained from the DADS postes. Other motives include the temporary replacement of the business owner, the recruitment of unemployed people facing professional challenges, the complementation of professional training, the replacement of an employee that is temporarily working part-time, and contracts with a clearly defined objectif.

Table A.2.2 reports some summary statistics related to our final data. In total, the DADS postes from 2017 to 2019 report roughly 19 million employees in the private sector. 42% of them are observed in more than one job, and on average we observe 1.9 jobs per worker. 36% of them are observed in more than one establishment, and on average we observe 1.65 establishments per worker. Finally, 71% of them are observed in more than one year.

TABLE A.2.2. Number of jobs, firms and years observed per worker

	mean	sd	share >1	N. workers
N. jobs	1.93	1.55	42%	18'732'844
N. firms	1.65	1.17	36%	18'732'844
N. years	2.19	0.86	71%	18'732'844

Note: This table reports the average number of distinct jobs that workers have in our sample (defined by the French statistical office as the interaction between a contract, an establishment and an occupation), the average number of establishments for which they work, and the average number of years in which we observe them, over the period from 2017-2019.

Table A.2.3 further explores the average characteristics of the individuals in the full sample, the sample of workers observed in more than one job, and the sample of workers observed in more than one establishment (for TWA workers, we consider the using establishment). Workers observed in more than one job or one establishment are on average younger, are more likely to hold TWA contracts over the period, and have slightly lower wages. Finally, workers holding both types of contracts over the three years – TWA and in-house – are younger, more likely to be male, and earn lower wages, in line with the descriptive statistics presented in the main text showing that such contracts are more prevalent among low-skill occupations.

TABLE A.2.3. Characteristics of workers across sample-selections

	all workers	workers > 1 job	workers > 1 estab.	workers TWA & in-house contr.
	mean/(sd)	mean/(sd)	mean/(sd)	mean/(sd)
age	38	36	35	32
	(12.48)	(11.67)	(11.60)	(11.00)
share women	0.38	0.35	0.36	0.32
	(0.48)	(0.48)	(0.48)	(0.47)
share TWA contracts	0.16	0.24	0.25	0.48
	(0.33)	(0.35)	(0.36)	(0.19)
wage	18.3	17.4	17.1	13.8
	(9.7)	(8.5)	(8.3)	(2.97)
N. workers	18’732’844	7’794’007	6’694’324	2’071’414

Note: This table reports the average characteristics of workers observed in different sub-samples: those observed in more than one job, those observed in more than one establishment, and those observed in both types of contracts: TWA and in-house. Source: DADS postes 2017-2019.

Given that our identification of contract-specific wage premia relies on individuals that move across contracts, establishments and markets over the period, Table A.2.3 summarizes how many individuals are concerned by such transitions. About 2 million workers are observed holding both TWA and in-house contracts, which corresponds to 11% of workers in the sample, and 31% of workers that work in more than one establishment. The large majority of them transitions also across establishments and occupations when changing contract type. This feature ensures that we have enough variation to identify contract-specific wage premia across markets and establishments.

TABLE A.2.4. Number of workers observed under both TWA and in-house contracts

	N. workers	share of tot workers	share of workers >1 firm
TWA & inhouse	2’071’414	11%	31%
TWA & inhouse in diff. estab	1’896’804	10%	28%
TWA & inhouse in diff. estab x occ	2’003’580	11%	30%
TWA & in-house in diff. CZ x occ	1’897’143	10%	28%

Note: This table reports the number of workers observed across both TWA and in-house contracts, distinguishing between whether the transition happens across establishments, occupations and markets. Source: DADS postes 2017-2019.

A.3 Robustness and additional results AKM Analysis

Table A.3.1 reports the frequency of transitions across contract types. Especially within fixed-term contracts, we see very similar frequencies of moves in both direction : 16% of in-house fixed-term contracts switch to TWA contracts, and 15% of TWA contracts switch to in-house fixed-term. Finally, very few open-ended contracts switch to fixed-term, but a similar proportion of them switch to fixed-term in-house and to TWA (3% to 4%).

TABLE A.3.1. Frequency of transitions across contract types

	Transitions		
	Number	**Share of all transitions**	**Share within type**
Full sample of individuals with 2 obs.			
CDI - CDI	21396635	64%	93%
CDI - CDD	862286	3%	4%
CDI - TWA	679524	2%	3%
CDD - CDD	2556758	8%	56%
CDD - CDI	1237097	4%	27%
CDD - TWA	740755	2%	16%
TWA - TWA	4054220	12%	69%
TWA - CDI	915854	3%	16%
TWA - CDD	877626	3%	15%

Note: This table reports the number of workers observed switching across contracts among all workers observed twice in the data. CDI identify in-house open-ended contracts while CDD are in-house fixed-term contracts. Source: DADS postes 2017-2019.

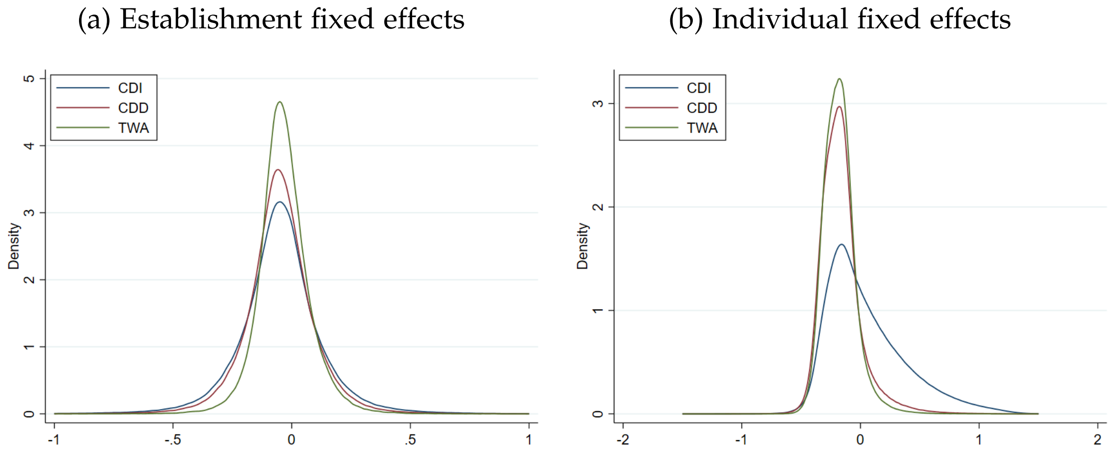
Figure A.3.1 shows the distribution of establishment and individual fixed effects for different types of contracts obtained from a standard AKM regression on log wages. We see that the types of establishments engaging in different types of contracts are highly comparable, with only a slight skeweness to the right of establishments using TWA contracts relative to in-house. Individuals with open-ended contracts (CDI) are on average more productive but, within fixed-term contracts, individuals taking in-house (CDD) and TWA jobs are highly comparable.

Figure A.3.2 shows the distribution of the wage gaps obtained within establishments, establishments - occupations, and commuting zones - occupations - productivity groups when we only consider fixed-term contracts among in-house arrangements.

Figure A.3.3 displays the distribution of the occupation $\times$ establishment effects and the occupation $\times$ commuting zone $\times$ productivity group effects for each contract type obtained from the estimation of equations (3) and (4) respectively. Beyond the lower average observed within TWA contracts, we also observe a much narrower distribution, revealing that there is also much less variation in TWA workers' pay across establishments and markets relative to what we observe among in-house contracts.

Figure A.3.4 computes the correlation between the in-house specific premium within an establishment and market and the wage-gap between in-house workers and temp workers. We see that regardless of the level of aggregation taken into account, there is a strong positive correlation between the two. Here we only report the graphs computed on the full sample of in-house contracts. Restricting the sample to fixed-term contracts give rise to very similar

FIGURE A.3.1. DISTRIBUTION OF ESTABLISHMENT AND INDIVIDUAL FIXED EFFECTS ACROSS CONTRACT TYPES



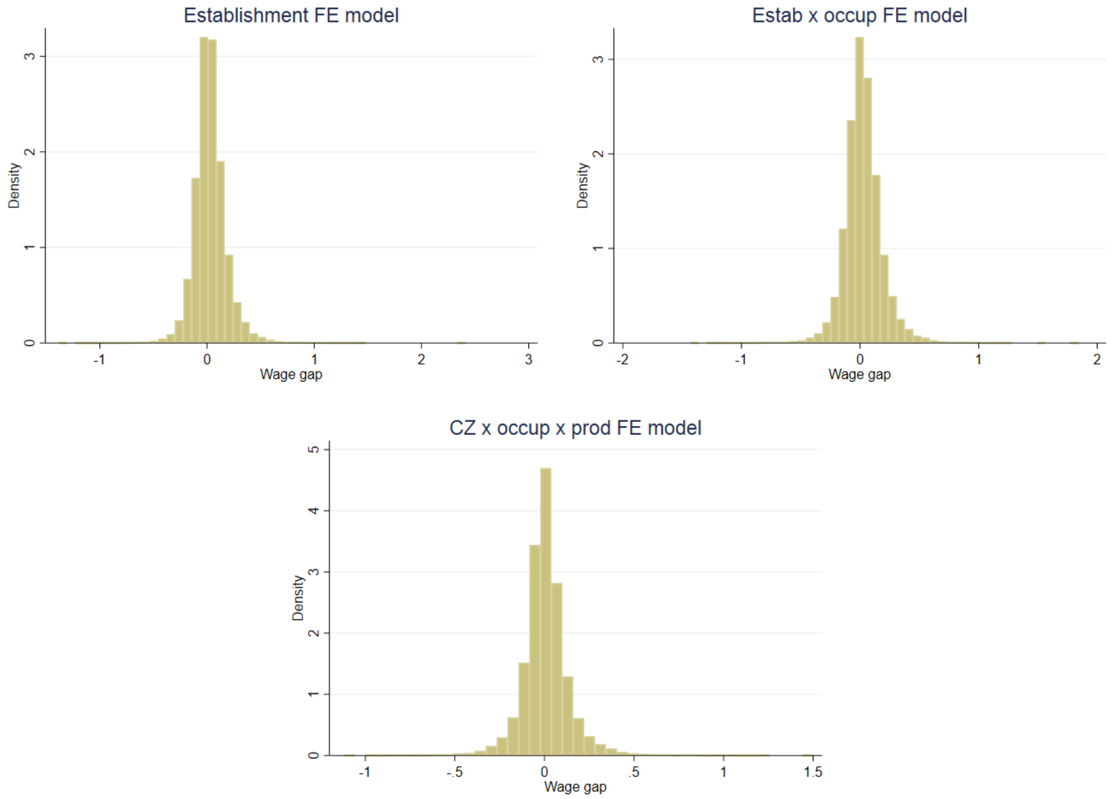
Notes: Distribution obtained from a standard AKM regression of log wages on individual and establishment fixed effects. The figure plots the distribution of the fixed effects across contract types: open-ended in-house (CDI), fixed-term in-house (CDD) and TWA.

results.[22]

Table A.3.2 computes the amount of pass-through obtained from regressing the premium for TWA contracts on the premium for in-house contracts within establishments (Columns 1 and 4), establishments-occupations (Columns 2 and 5), and employment zones-occupations-productivity groups (Columns 3 and 6). This exercise is similar to the main result shown in Drenik et al. (2020). At the establishment-level the pass-through is of 43%, in line with the one found by Drenik et al. (2020) in Argentina (approaching 50%). When we compare within the same occupation and establishment we find a slightly higher pass-through than when the occupation dimension is omitted, highlighting the importance of taking this level into consideration. The pass-through obtained at the market level is on the contrary lower, around 27%. Excluding open-ended contracts makes virtually no difference for these results.

[22] Available upon request.

FIGURE A.3.2. Distribution of wage gaps using only fixed-term contracts



Notes: Distribution of the wage gaps between in-house and temporary workers recovered using equations (2), (3) and (4) on the sample of fixed-term contracts.

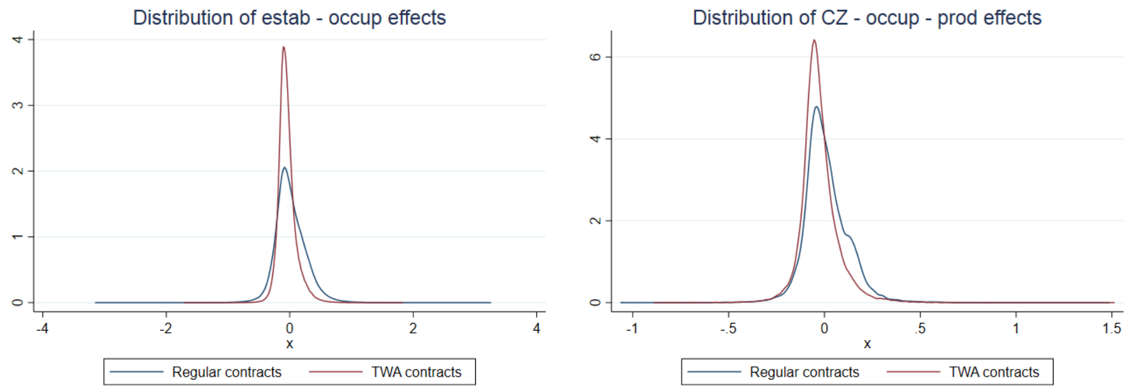
TABLE A.3.2. Wage pass-through by contract type

	(1)	(2)	(3)	(4)	(5)	(6)
		All sample			Fixed term only	
VARIABLES	γ_x^H	γ_x^H	γ_x^H	γ_x^H	γ_x^H	γ_x^H
γ_x^T	0.436***	0.536***	0.273***	0.488***	0.546***	0.230***
	(0.00315)	(0.00287)	(0.00571)	(0.00503)	(0.00499)	(0.00842)
$x = e$	yes			yes		
$x = eo$		yes			yes	
$x = zop$			yes			yes
Observations	165,437	152,732	27,190	85,512	54,886	22,563
R-squared	0.104	0.185	0.078	0.099	0.179	0.032

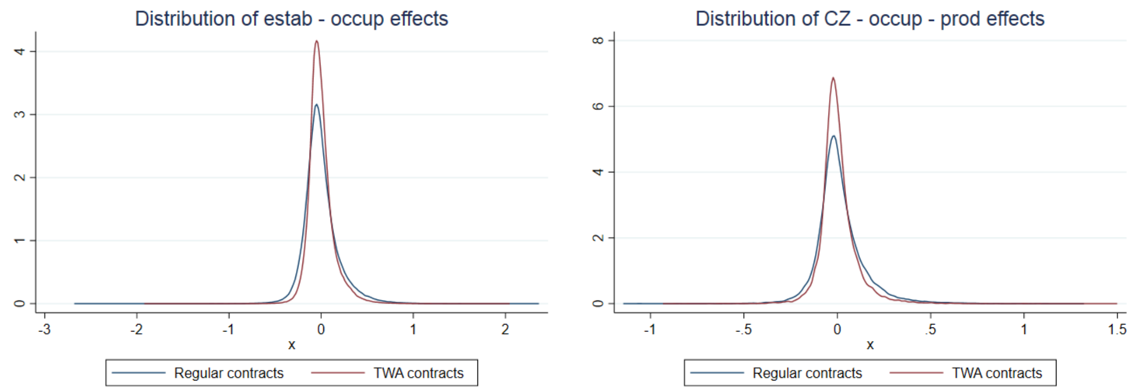
Note: This table reports the result of six separate regressions. Columns (1) and (4) regress TWA wage premia within firms on in-house premia. Columns (2) and (5) do the same but compute the premia within firms and occupations. Columns (3) and (6) regress TWA wage premia within markets, as defined by the occupation and commuting zone. The regression samples are restricted to the set of establishments and markets for which we could identify the two types of wage premia using all in-house contracts or only fixed-term contracts respectively. Clustered standard errors (occupation*CZ) are reported in parentheses. Source: DADS POSTES 2017-2019.

FIGURE A.3.3. Firms' and markets' wage premia by contract type

(a) All in-house contracts



(b) Only in-house fixed-term contracts



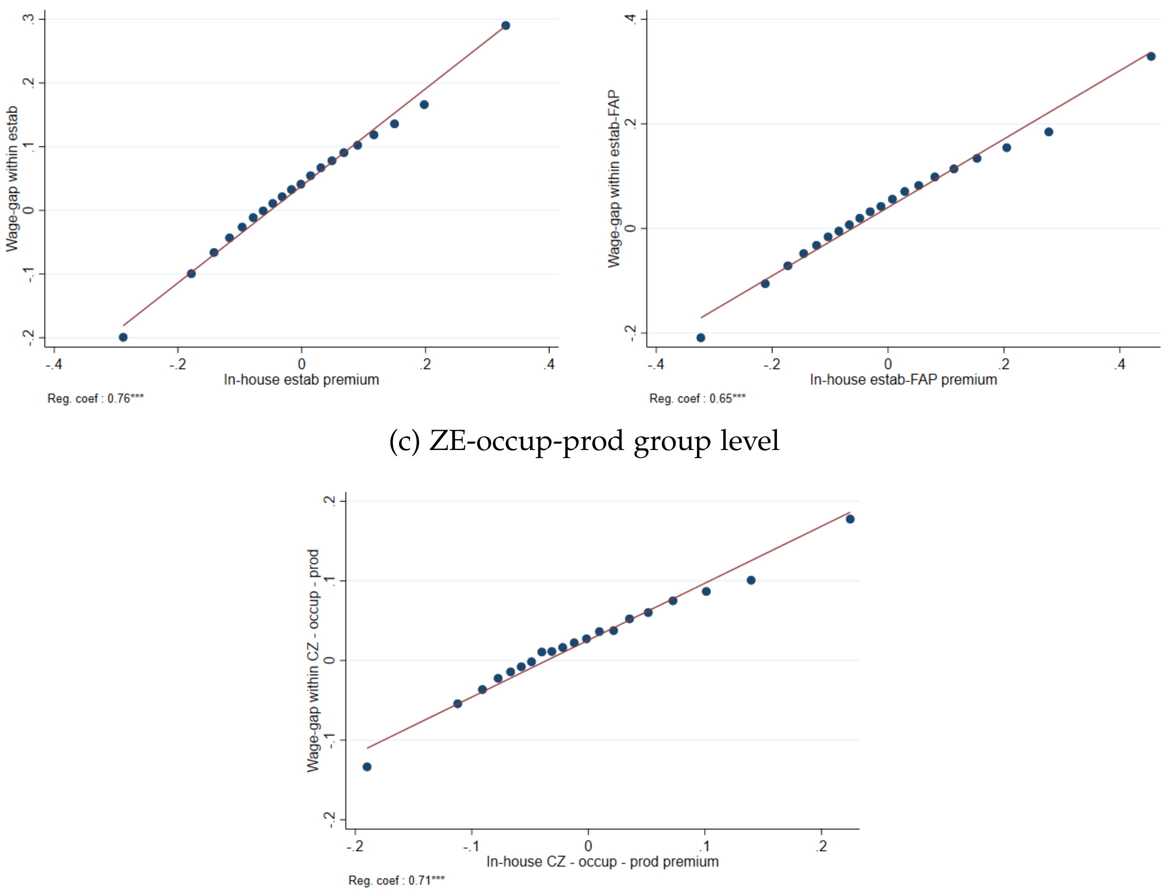
Note: This graph represents the density of establishments' and market wage premia by contract type. Source: DADS POSTES 2017-2019.

FIGURE A.3.4. CORRELATION IN-HOUSE PREMIUM AND IN-HOUSE TO TWA WAGE-GAP

(a) Firm level

(b) Firm-occup level

(c) ZE-occup-prod group level

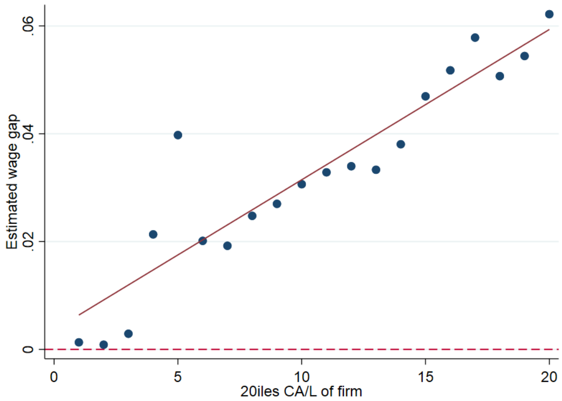


Note: This figure correlates the wage gap obtained with $\gamma_x^H - \gamma_x^T$ with the in-house specific premium γ_x^H. Panel a) computes it at the establishment level, panel b) at the establishment-occupation level, panel c) at the CZ-occupation-productivity group level. Source: DADS POSTES 2017-2019.

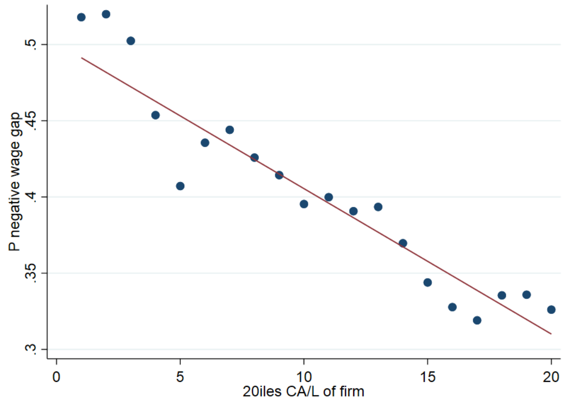
Finally one might wonder whether the 25% of cells with wage gaps in favor of TWA workers might not be subject to measurement error, for instance driven by some cells being too small. We perform two robustness tests to convince the reader that measurement error is not driving our results. First, Figure A.3.5 correlates the wage gaps obtained from the AKM regression with firm level characteristics including 20iles of revenues per worker and firm size. The picture shows that wage gaps are strongly positively correlated with larger firms and firms with higher revenues per worker. Similarly, we find 50% (55%) of negative wage gaps within firms at the bottom of the revenue per worker (size) distribution, and only 30% for firms at the top of these distributions. Second, to check whether results are robust to using larger cells, we apply a methodology similar to Bonhomme et al. (2019), consisting in dividing firms into 20 clusters based on their wage levels, and then run the AKM model by interacting these 20 clusters with contract type. Table III in the main text shows the distribution of wage gaps obtained within the 20 clusters. While the fact that the distribution becomes much narrower is to be expected given the significant reduction in observations, it is interesting to notice that roughly 25% of the sample maintains a wage gap in favor of TWA workers. Finally, Figure A.3.6 shows that the clusters with wage gaps in favor of TWA are concentrated in the lower paying classes. All in all, these results confirm that the presence of a significant portion of firms where TWA workers are paid more than in-house is not driven by measurement error or small sample bias.

FIGURE A.3.5. Correlation between wage gaps and other firm characteristics

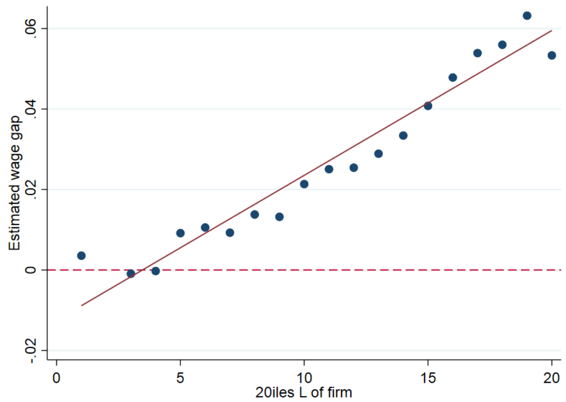
(a) Wage gaps and revenues/worker



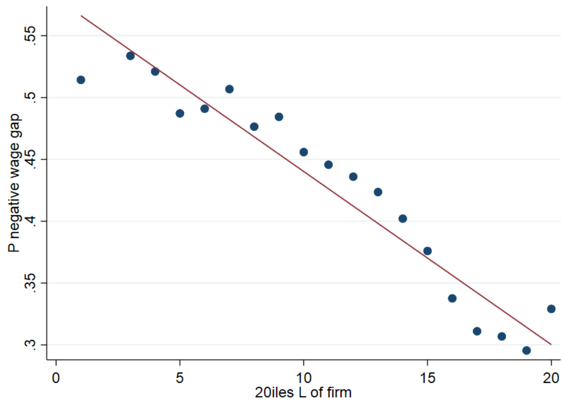
(b) Sh. negative wage gaps and rev/worker



(c) Wage gaps and firm size



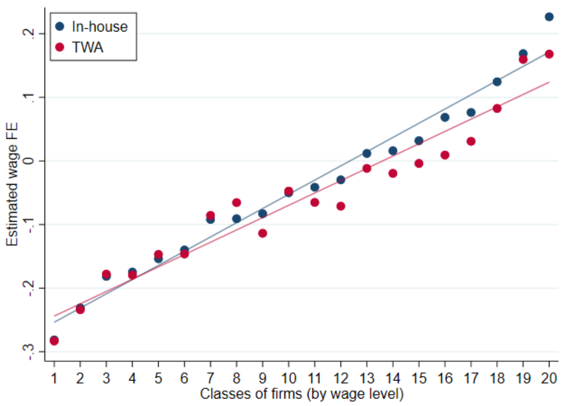
(d) Sh. negative wage gaps and firm size



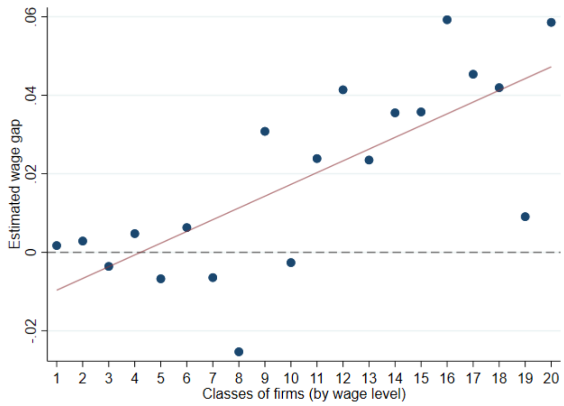
Note: This figure shows how the wage gap between in-house and TWA workers obtained from AKM regressions correlates with firm characteristics, including their size and revenues per worker. The latter are split into 20iles for simplicity.

FIGURE A.3.6. Wages and wage gaps along BLM clusters

(a) Level of in-house and TWA FE



(b) Difference in in-house and TWA FE



Note: This figure shows how the contract specific firm cluster fixed effects, obtained applying a methodology inspired by Bonhomme et al. (2019), are distributed along the clusters ordered from the lowest paying one to the highest paying one.

B Model Appendix

This appendix presents the solution of the model presented in the main text.

B.1 Value functions and offered wages

B.1.1 Workers

Denoting by W_u the expected value from unemployment and by b the income when unemployed, the arbitrage condition implies that

$$rW_u = b + \theta m(\theta)\left(W(w) - W_u\right), \text{ for all } (w, \theta) \tag{B.19}$$

where

$$rW(w) = w + q(W_u - W(w)) \tag{B.20}$$

From these two equations, the arbitrage condition can be rewriten as

$$(w - rW_u)\theta m(\theta) = (r+q)(rW_u - b) \tag{B.21}$$

This equation defines a relation between the wage w and the labor market tightness in each submarket:

$$\frac{\partial \theta}{\partial w} = -\frac{\theta}{1-\eta}\frac{r+q}{(W(w) - W_u)}, \eta = -\frac{\theta m'(\theta)}{m(\theta)}$$

B.1.2 Firms

There is an exogenous number of identical firms normalized to one. Each firm can produce with $\mathcal{L}_h \geq 0$ in-house workers and $\mathcal{L}_a \geq 0$ temp workers. The number of workers employed by each firm is

$$\mathcal{L} = \mathcal{L}_h + \mathcal{L}_a$$

Firms choose the number of in-house and temp job vacancies. They also choose the wage associated with their in-house job offers. Let us denote by $\mathrm{d}t \to 0$ a small interval of time and by $x^+ - x$ the variation of variable x over the time interval $\mathrm{d}t$. The value function of a firm satisfies

$$(1 + r\mathrm{d}t)\,\Pi\left(\mathcal{L}\right) = \max_{(\mathcal{V}_h \geq 0, \mathcal{V}_a \geq 0, w)} \left[y\mathcal{L} - (w_h + c_h)\,\mathcal{L}_h - C(\mathcal{V}_h) - rk\left(\mathcal{L} + \mathcal{V}_h + \mathcal{V}_a\right) - p\mathcal{L}_a\right]\mathrm{d}t + \Pi\left(\mathcal{L}^+\right)$$

subject to (B.21) and the law of motion of in-house and temp jobs:

$$\begin{aligned} \mathcal{L}_h^+ &= (1 - q\mathrm{d}t)\,\mathcal{L}_h + \mathcal{V}_h m(\theta_h)\mathrm{d}t \\ \mathcal{L}_a^+ &= (1 - q\mathrm{d}t)\,\mathcal{L}_a + \alpha\mathcal{V}_a m(\theta_a)\mathrm{d}t \end{aligned}$$

Let us denote by μ_h and μ_a the multipliers associated with the constraints $\mathcal{V}_h \geq 0, \mathcal{V}_a \geq 0$.
The offered wage satisfies

$$w_h = \eta\left(y - rk - c_h - rW_u\right) + rW_u \tag{B.22}$$

The first order conditions yield

$$\begin{aligned} -C'(\mathcal{V}_h) - rk + \Pi'\left(\mathcal{L}^+\right) m(\theta_h) + \mu_h &= 0 &\text{(B.23)}\\ -rk + \Pi'\left(\mathcal{L}^+\right) \alpha m(\theta_a) + \mu_a &= 0 &\text{(B.24)}\end{aligned}$$

The envelope conditions yield

$$\begin{aligned}(1 + r\mathrm{d}t)\,\Pi'\left(\mathcal{L}\right) &= \left(y - rk - w_h - c_h\right)\mathrm{d}t + (1 - q\mathrm{d}t)\,\Pi'\left(\mathcal{L}\right)\\ (1 + r\mathrm{d}t)\,\Pi'\left(\mathcal{L}\right) &= \left(y - rk - p\right)\mathrm{d}t + (1 - q\mathrm{d}t)\,\Pi'\left(\mathcal{L}\right)\end{aligned}$$

or

$$\Pi'\left(\mathcal{L}\right) = \frac{y - rk - w_h - c_h}{r + q} = \frac{y - rk - p}{r + q} \tag{B.25}$$

- Let us first consider interior solutions, with $\mu_h = \mu_a = 0$. In this case, the first order conditions yield, together with the envelop condition (B.25) and the wage equation (B.22):

  $$C'(\mathcal{V}_h) + rk = (1 - \eta)m(\theta_h)\frac{y - rk - rW_u - c_h}{r + q} \tag{B.26}$$

  and

  $$rk = \alpha m(\theta_a)\frac{y - rk - p}{r + q} \tag{B.27}$$

  Equation (B.26) defines the demand for the vacancies for temp jobs. It shows that the expected marginal cost of in-house vacancies, equal to the cost of looking for a worker $C'(\mathcal{V}_h)$ plus the maintenance cost of vacant jobs, rk, is equal to their expected profits. Similarly, the cost of posting a vacant position for a temp worker, equal to the maintenance cost of the vacant job, is equal to its expected profit. The first order conditions imply that an interior solution with $\mathcal{V}_h > 0$ and $\mathcal{V}_a > 0$ exists if and only if:

  $$(1 - \eta)m(\theta_h)\frac{y - rk - rW_u - c_h}{r + q} - rk > 0 \text{ and } y - rk - p > 0$$

  These two conditions allow us to analyze the corner solutions which correspond to situations in which firms do not use both in-house and temp workers, for a given value of $(\theta_h, \theta_a, W_u, p)$.

- Firms only use temp workers according to condition (B.27) when

  $$(1 - \eta)m(\theta_h)\frac{y - rk - rW_u - c_h}{r + q} - rk < 0 \text{ and } y - rk - p > 0.$$

- Firms only use in-house workers according to condition (B.26) when

$$(1-\eta)m(\theta_h)\frac{y-rk-rW_u-c_h}{r+q}-rk>0 \text{ and } y-rk-p<0$$

- Firms hire nobody when

$$(1-\eta)m(\theta_h)\frac{y-rk-rW_u-c_h}{r+q}-rk<0 \text{ and } y-rk-p<0$$

B.1.3 TWAs

The TWAs look for temp workers for the vacancies posted by user firms. TWAs set the wage of temp workers, denoted by w_a. TWAs get the price p per vacancy filled by a temp worker. The value of vacancies, V_a, posted at the TWAs satisfies:

$$rV_a=\max_{w_a}-\kappa+\alpha m(\theta_a)\left(\frac{p-w_a+c_a}{r+q}-V_a\right) \text{ subject to (B.21)}$$

The offered wage satisfies

$$w_a=\eta\left(p-c_a-rW_u\right)+rW_u \tag{B.28}$$

B.2 Labor market equilibrium

B.2.1 Equilibrium with temp and in-house jobs

When firms use both temp and in-house jobs, the free entry condition implies that the value of vacancies posted by TWAs is equal to zero: $V_a=0$. From the definitions of V_a and w_a we get

$$\frac{\kappa}{\alpha m(\theta_a)}=(1-\eta)\left(\frac{p-c_a-rW_u}{r+q}\right) \tag{B.29}$$

This is the equation of supply of TWAs' vacancies arising from the free entry condition on the market for temp workers.

From the arbitrage equation (B.19), the wage equations and the labor demand equations (B.26) and (B.29) we get the relations

$$rW_u = b+\frac{\eta\theta_a}{\alpha\left(1-\eta\right)}\kappa \tag{B.30}$$

$$rW_u = b+\frac{\eta\theta_h}{(1-\eta)}\left[C'(\mathcal{V})+rk\right] \tag{B.31}$$

Now, we can define the equilibrium value of the labor market tighness of the submarket for temp jobs from the equality between the demand (equation (B.27)) and the supply (equation

(B.29)) for temp jobs. Substituting the value of rW_u defined by equation (B.30), into the supply and demand equations, the equality between the supply and demand of TWAs' vacancies yields:

$$\kappa = \frac{\alpha m(\theta_a)(1-\eta)}{r+q+\eta\theta_a m(\theta_a)}\left(y - rk - c_a - b - \frac{r+q}{\alpha m(\theta_a)} rk\right) \tag{B.32}$$

The left hand side of this equation is the cost of vacancies for the TWA per unit of time and the right hand side the expected gains from filled vacancies. The right-hand side decreases with θ_a. Therefore, this equation defines a unique value of θ_a provided it exists.

Equation (B.31) defines the expected value of unemployed workers looking for in-house jobs. From this expected value and the demand or in-house workers (B.27) we get the following equilibrium condition:

$$C'(\mathcal{V}_h) + rk = \frac{m(\theta_h)(1-\eta)}{r+q+\eta\theta_h m(\theta_h)}(y - rk - c_h - b) \tag{B.33}$$

which defines a relation between the tightness of the submarket for in-house jobs and the number of vacancies for in-house jobs.

Eventually, the equalization of the reservation wage of unemployed workers defined by equations (B.30) and (B.31) yields, together with equations (B.32) and (B.33), the relation between the labor market tighnesses arising from the arbitrage of unemployed workers between submarkets:

$$\frac{\theta_h m(\theta_h)(y - rk - c - b)}{r+q+\eta\theta_h m(\theta_h)} = \frac{\theta_a m(\theta_a)}{r+q+\eta\theta_a m(\theta_a)}\left(y - rk - c_a - b - \frac{r+q}{\alpha m(\theta_a)} rk\right)$$

This equation defines a unique value of θ_h for each value of θ_a, provided it exists.

From the previous results, the equilibrium values $(\theta_a, \theta_h, \mathcal{V}_h)$ are defined by the system of equations

$$\kappa + rk - \eta\frac{r+q+\theta_a m(\theta_a)}{r+q+\eta\theta_a m(\theta_a} rk = \frac{\alpha m(\theta_a)(1-\eta)}{r+q+\eta\theta_a m(\theta_a)}(y - rk - c_a - b) \tag{B.34}$$

$$\frac{\theta_h m(\theta_h)(y - rk - c_h - b)}{r+q+\eta\theta_h m(\theta_h)} = \frac{\theta_a m(\theta_a)}{r+q+\eta\theta_a m(\theta_a)}\left(y - rk - c_a - b - \frac{r+q}{\alpha m(\theta_a)} rk\right) \tag{B.35}$$

$$C'(\mathcal{V}_h) + rk = \frac{m(\theta_h)(1-\eta)}{r+q+\eta\theta_h m(\theta_h)}(y - rk - c_h - b) \tag{B.36}$$

Remark that this system of equations can be solved recursively. Equation (B.34) defines θ_a. Then, equation (B.35) defines θ_h and equation (B.36) defines $\mathcal{V}_h$. Each equation has a single solution, provided it exists. Therefore, the equilibrium is unique.

Then, the steady state equilibrium value of $\mathcal{V}_a$ is defined by the resource constraint

$$\mathcal{N} = \mathcal{U}_h + \mathcal{L}_h + \mathcal{U}_a + \mathcal{L}_a$$

where

$$\mathcal{U}_h = \frac{\mathcal{V}_h}{\theta_h}, \mathcal{U}_a = \frac{\alpha \mathcal{V}_a}{\theta_a}, \mathcal{L}_h = \frac{\mathcal{V}_h m(\theta_h)}{q}, \mathcal{L}_a = \frac{\alpha \mathcal{V}_a m(\theta_a)}{q}$$

which allows us to write the resource constraint as

$$\mathcal{V}_a = \left(\mathcal{N} - \mathcal{V}_h \frac{q + \theta_h m(\theta_h)}{q\theta_h} \right) \frac{q\theta_a}{\alpha \left[q + \theta_a m(\theta_a) \right]}$$

Now, let us define the conditions in which an interior solution with $\mathcal{V}_h > 0$ and $\mathcal{V}_a > 0$ exists. Since $\lim_{\theta \to 0} m(\theta) = +\infty$, $\lim_{\theta \to \infty} m(\theta) = 0$, $\lim_{\theta \to \infty} \theta m(\theta) = \infty$, $\lim_{\theta \to 0} \theta m(\theta) = 0$, equation (B.34) implies that a solution with $\theta_a > 0$ and thus $\mathcal{V}_a > 0$ can exist only if

$$y - rk - c_a - b > 0$$

In that case, the arbitrage equation (B.35) defines, together with equation (B.34), a unique value of θ_h which is defined by

$$\begin{cases} \theta_h m(\theta_h) = (r+q) \left(\frac{(1-\eta)\alpha(y-rk-c_h-b)}{\kappa \theta_a} - \eta \right)^{-1} & \text{if } \frac{(1-\eta)\alpha(y-rk-c_h-b)}{\kappa \theta_a} - \eta > 0 \\ \theta_h = 0 & \text{otherwise} \end{cases} \tag{B.37}$$

The number of vacancies for in-house workers is defined by

$$\begin{cases} C'(\mathcal{V}_h) = \frac{(1-\eta)m(\theta_h)(y-rk-c_h-b)}{r+q+\eta\theta_h m(\theta_h)} - rk & \text{if } \frac{(1-\eta)m(\theta_h)(y-rk-c_h-b)}{r+q+\eta\theta_h m(\theta_h)} - rk > 0 \\ \mathcal{V}_h = 0 & \text{otherwise} \end{cases}$$

Therefore, the decentralized equilibrium has temp and in-house workers if and only if

$$\frac{(1-\eta)\,\alpha\,(y - rk - c_h - b)}{\kappa \theta_a} > \eta \tag{A}$$

$$\frac{(1-\eta)\, m(\theta_h)\, (y - rk - c_h - b)}{r + q + \eta \theta_h m(\theta_h)} > rk \tag{B}$$

$$y - rk - c_a - b > 0 \tag{C}$$

where θ_a is defined by (B.34) and θ_h by (B.37).

B.2.2 Equilibrium with temp jobs only

If either condition (A) or condition (B) or (C) is not satisfied, the equilibrium cannot have both in-house and temp jobs. If there are only temp jobs, the values of θ_a and $\mathcal{V}_a$ are defined by:

$$\begin{aligned}\kappa &= \frac{\alpha m(\theta_a)(1-\eta)}{r+q+\eta\theta_a m(\theta_a)}\left(y-rk-c_a-b-\frac{r+q}{\alpha m(\theta_a)}rk\right)\\ \mathcal{V}_a &= \mathcal{N}\frac{q\theta_a}{\alpha\left[q+\theta_a m(\theta_a)\right]}.\end{aligned}$$

B.2.3 Equilibrium with in-house jobs only

If there are in-house jobs only the equilibrium values of $\mathcal{V}_h > 0$ and $\theta_h > 0$ are uniquely defined by the equality between the marginal cost of vacancies and their expected profits, and the resource constraint:

$$\begin{aligned}C'(\mathcal{V}_h)+rk &= \frac{m(\theta_h)(1-\eta)}{r+q+\eta\theta_h m(\theta_h)}(y-rk-c_h-b)\\ \mathcal{V}_h &= \mathcal{N}\frac{q\theta_h}{q+\theta_h m(\theta_h)}\end{aligned}$$

because it is assumed that $\lim_{\mathcal{V}_h\to 0} C'(\mathcal{V}_h)=0$, $\lim_{\theta_h\to 0} m(\theta_h)=+\infty$, $\lim_{\theta_h\to+\infty} m(\theta_h)=0$

B.3 Constrained efficient solution

The social planner maximizes the discounted net output subject to the law of motion of in-house and temp employment respectively denoted by $\mathcal{L}_h$ and $\mathcal{L}_a$. The maximization problem which defines the constrained efficient allocation is:

$$\max_{(\mathcal{U}_h,\mathcal{U}_a,\mathcal{V}_h\geq 0,\mathcal{V}_a\geq 0)}\int_0^\infty\left[(\mathcal{N}-\mathcal{L})b+y\mathcal{L}-\mathcal{L}_a c_a-\mathcal{L}_h c_h-\kappa\mathcal{V}_a-C(\mathcal{V}_h)-rk(\mathcal{L}_a+\mathcal{L}_h+\mathcal{V}_h+\mathcal{V}_a)\right]e^{-rt}\mathrm{d}t$$

subject to

$$\begin{aligned}\dot{\mathcal{L}}_h &= \mathcal{V}_h m(\theta_h)-q\mathcal{L}_h\\ \dot{\mathcal{L}}_a &= \alpha\mathcal{V}_a m(\theta_a)-q\mathcal{L}_a\\ \mathcal{N} &= \mathcal{L}_a+\mathcal{L}_h+\mathcal{U}_a+\mathcal{U}_h\\ \text{where } \theta_a &= \frac{\alpha\mathcal{V}_a}{\mathcal{U}_a};\theta_h=\frac{\mathcal{V}_h}{\mathcal{U}_h};\mathcal{L}=\mathcal{L}_a+\mathcal{L}_h\end{aligned}$$

Let λ_h and λ_a denote the multipliers associated with the law of motion of in-house and temp employment, χ_h and χ_a the multipliers associated with the constraints $\mathcal{V}_h\geq 0, \mathcal{V}_a\geq 0$, and γ the multiplier associated with the constraint $\mathcal{N}=\mathcal{L}_a+\mathcal{L}_h+\mathcal{U}_a+\mathcal{U}_h$. Note that there no possible solutions with $\mathcal{U}_a \leq 0$ or $\mathcal{U}_h \leq 0$ if $\mathcal{V}_h \geq 0$ and $\mathcal{V}_a \geq 0$ because $m(\theta)$ is only defined for strictly positive values of θ. Therefore, θ_a and θ_h are defined only if $\mathcal{U}_a > 0$ and $\mathcal{U}_h > 0$.

The current Hamiltonian of the planner's problem is written

$$\begin{aligned} H &= (\mathcal{N}-\mathcal{L})\, b + y\mathcal{L} - \mathcal{L}_a c_a - \mathcal{L}_h c_h - \kappa\mathcal{V}_a - C(\mathcal{V}_h) - rk\,(\mathcal{L}_a + \mathcal{L}_h + \mathcal{V}_h + \mathcal{V}_a) \\ &\quad + \lambda_h\,[\mathcal{V}_h m(\theta_h) - q\mathcal{L}_h] + \lambda_a\,[\alpha\mathcal{V}_a m(\theta_a) - q\mathcal{L}_a] + \gamma\,[\mathcal{N} - (\mathcal{L}_a + \mathcal{L}_h + \mathcal{U}_a + \mathcal{U}_h)] \\ &\quad + \chi_a\mathcal{V}_a + \chi_h\mathcal{V}_a \end{aligned}$$

The first order conditions are

$$\begin{aligned} \frac{\partial H}{\partial \mathcal{V}_h} &= -\left[C'(\mathcal{V}_h) + rk\right] + \lambda_h\,(1-\eta)\,m(\theta_h) + \chi_h = 0 \\ \frac{\partial H}{\partial \mathcal{V}_a} &= -\,(\kappa + rk) + \lambda_a \alpha m(\theta_a)\,(1-\eta) + \chi_a = 0 \\ \frac{\partial H}{\partial \mathcal{U}_h} &= \lambda_h \eta \theta_h m(\theta_h) - \gamma = 0 \\ \frac{\partial H}{\partial \mathcal{U}_a} &= \lambda_a \eta \theta_a m(\theta_a) - \gamma = 0 \\ \frac{\partial H}{\partial \mathcal{L}_h} &= y - rk - c_h - b - \lambda_h q - \gamma = r\lambda_h \\ \frac{\partial H}{\partial \mathcal{L}_a} &= y - rk - c_a - b - \lambda_a q - \gamma = r\lambda_a \end{aligned}$$

The exclusion relations are:

$$\begin{aligned} \chi_a\mathcal{V}_a &= 0 \\ \chi_h\mathcal{V}_h &= 0 \end{aligned}$$

B.3.1 Constrained efficient solution with temp and in-house jobs

Let us first look for an interior solution such that $\chi_a = \chi_h = 0$. We get:

$$\begin{aligned} \frac{\partial H}{\partial \mathcal{V}_h} &= 0 \Leftrightarrow C'(\mathcal{V}_h) + rk = (1-\eta)\,m(\theta_h)\lambda_h \\ \frac{\partial H}{\partial \mathcal{V}_a} &= 0 \Leftrightarrow \kappa + rk = \lambda_a \alpha m(\theta_a)\,(1-\eta) \\ \frac{\partial H}{\partial \mathcal{U}_h} &= 0 \Leftrightarrow \lambda_h \eta \theta_h m(\theta_h) = \gamma \\ \frac{\partial H}{\partial \mathcal{U}_a} &= 0 \Leftrightarrow \lambda_a \eta \theta_a m(\theta_a) = \gamma \\ \frac{\partial H}{\partial \mathcal{L}_h} &= r\lambda_h \Leftrightarrow y - rk - c_h - b = (r+q)\,\lambda_h + \gamma \\ \frac{\partial H}{\partial \mathcal{L}_a} &= r\lambda_a \Leftrightarrow y - rk - c_a - b = (r+q)\,\lambda_a + \gamma \end{aligned}$$

These first order conditions, together with the definition of the labor market tightnesses and the labor market flows equilibrium, yield the system of equations which defines the constrained efficient values of $(\theta_a, \theta_h, \mathcal{V}_h)$ provided they exist:

$$\kappa + rk = \frac{\alpha m(\theta_a^*)\,(1-\eta)}{r+q+\eta\theta_a^* m(\theta_a^*)}\,(y - rk - c_a - b) \tag{B.38}$$

$$\frac{\theta_h^* m(\theta_h^*)\,(y - rk - c_h - b)}{r+q+\eta\theta_h^* m(\theta_h^*)} = \frac{\theta_a^* m(\theta_a^*)}{r+q+\eta\theta_a^* m(\theta_a^*)}\,(y - rk - c_a - b) \tag{B.39}$$

$$C'(\mathcal{V}_h^*) + rk = \frac{m(\theta_h^\star)\,(1-\eta)}{r+q+\eta\theta_h^* m(\theta_h^*)}\,(y - rk - c_h - b) \tag{B.40}$$

Now, let us define the conditions in which an interior solution with $\mathcal{V}_h > 0$ and $\mathcal{V}_a > 0$ exists. Since $\lim_{\theta\to 0} m(\theta) = +\infty$ and $\lim_{\theta\to\infty} m(\theta) = 0$, equation (B.38) implies that a solution with $\theta_a > 0$ and thus $\mathcal{V}_a > 0$ can exist only if

$$y - rk - c_a - b > 0$$

In this case, the arbitrage equation (B.39) defines, together with equation (B.38), a unique value of θ_h^* which is defined by

$$\begin{cases} \theta_h^* m(\theta_h) = (r+q)\left(\frac{(1-\eta)\alpha(y-rk-c_h-b)}{\kappa\theta_a^*} - \eta\right)^{-1} & \text{if } \frac{(1-\eta)\alpha(y-rk-c_h-b)}{\kappa\theta_a^*} > \eta \\ \theta_h^* = 0 & \text{otherwise} \end{cases} \tag{B.41}$$

The number of vacancies for in-house workers is defined by

$$\begin{cases} C'(\mathcal{V}_h^*) = \frac{(1-\eta)m(\theta_h^*)(y-rk-c_h-b)}{r+q+\eta\theta_h^\star m(\theta_h^*)} - rk & \text{if } \frac{(1-\eta)m(\theta_h^*)(y-rk-c_h-b)}{r+q+\eta\theta_h^\star m(\theta_h^*)} > rk \\ \mathcal{V}_h^* = 0 & \text{otherwise} \end{cases}$$

Therefore, the constrained efficient allocation has temp and in-house workers if and only if

$$\frac{(1-\eta)\,\alpha\,(y - rk - c_h - b)}{\kappa\theta_a^*} > \eta \tag{A*}$$

$$\frac{(1-\eta)\,m(\theta_h^*)\,(y - rk - c_h - b)}{r+q+\eta\theta_h^* m(\theta_h^*)} > rk \tag{B*}$$

$$y - rk - c_a - b > 0 \tag{C*}$$

where θ_a^* is defined by (B.38) and θ_h^* by (B.39).

B.3.2 Constrained efficient solution with in-house jobs only

If the contrained efficient solution has in-house jobs only, the values of $\mathcal{V}_h$ and θ_h are uniquely defined by the equality between the marginal cost of vacancies and their expected gains, and the resource constraint:

$$C'(\mathcal{V}_h^*) + rk = \frac{m(\theta_h^*)(1-\eta)}{r+q+\eta\theta_h^* m(\theta_h^*)}(y - rk - c_h - b) \tag{B.42}$$

$$\mathcal{V}_h^* = \mathcal{N}\frac{q\theta_h^*}{q+\theta_h^* m(\theta_h^*)} \tag{B.43}$$

because it is assumed that $\lim_{\mathcal{V}_h \to 0} C'(\mathcal{V}_h) = 0$.

B.3.3 Constrained efficient solution with temp jobs only

If the constrained efficient solution has temps jobs only, the value of θ_a, denoted θ_a^*, is defined by equation (B.38) and the number of vacancies is defined by the resource constraint:

$$\mathcal{V}_a^* = \mathcal{N}\frac{q\theta_a^*}{\alpha\left[q+\theta_a m(\theta_a^*)\right]}$$

B.4 Comparison of the decentralized equilibrium with the constrained efficient solution

This section compares the decentralized equilibrium with the constrained efficient solution. We compare each type of allocation (mixed, temp only, in-house only) and the sets of values of parameters in which each type of allocation arises.

B.4.1 Allocations with in-house and temp jobs

To show that $\theta_a^* < \theta_a$ and $\theta_h < \theta_h^\star$, we can write the equations defining the decentralized equilibrium and the constrained efficient solution. Let us define the (decreasing) function g as:

$$g(x) = \alpha(1-\eta)\frac{m(x)(y-rk-c_a-b)}{r+q+\eta x m(x)}$$

such that we must have (see equations (B.34) and (B.38)):

$$g(\theta_a^*) = \kappa + rk \quad \text{and} \quad g(\theta_a) = \kappa + rk - \underbrace{\eta\frac{r+q+\theta_a m(\theta_a)}{r+q+\eta\theta_a m(\theta_a)}}_{\equiv \mathcal{I}(\theta_a)>0}$$

This immediately shows that $\theta_a^* < \theta_a$ if and only if $k > 0$. Then using equations (B.35) and (B.39), we can define the (increasing) function f as:

$$f(x) = \frac{xm(x)(y - rk - c_h - b)}{r + q + \eta x m(x)}$$

such that:

$$f(\theta_h^*) = \frac{g(\theta_a^*)}{\alpha(1-\eta)} = \frac{\kappa + rk}{\alpha(1-\eta)} \quad \text{and} \quad f(\theta_h) = \frac{\kappa + rk - \mathcal{I}(\theta_a)}{\alpha(1-\eta)} \left(1 - \frac{(r+q)rk}{\alpha m(\theta_a)(y - rk - c_a - b)}\right)$$

If $k > 0$, $\mathcal{I}(\theta_a) > 0$ and because $\frac{(r+q)rk}{\alpha m(\theta_a)} < y - rk - c_a - b$, we have $f(\theta_h^*) > f(\theta_h)$ which directly implies $\theta_h^* > \theta_h$.

To compare employment in the constrained efficient allocation and in the decentralized equilibrium, we start from the equations defining the creation of in-house vacancies, (B.36) and (B.40), which display the same negative relation between $\mathcal{V}_h$ and θ_h across both equilibria. Therefore, $\theta_h^* > \theta_h$ implies that $\mathcal{V}_h^* < \mathcal{V}_h$, and that in-house worker employment, $\mathcal{L}_h = \mathcal{V}_h m(\theta_h)/q$, is lesser in the constrained efficient allocation than in the decentralized equilibrium, i.e., $\mathcal{L}_h^* < \mathcal{L}_h$. Similarly, the number of unemployed workers seeking in-house jobs, $\mathcal{U}_h = \mathcal{V}_h/\theta_h$, is reduced in the constrained efficient allocation compared to the decentralized equilibrium, i.e., $\mathcal{U}_h^* < \mathcal{U}_h$. We have demonstrated that $\mathcal{U}_h^* + \mathcal{L}_h^* < \mathcal{U}_h + \mathcal{L}_h$. Thus, the resource constraint $\mathcal{N} = \mathcal{L}_h + \mathcal{U}_h + \mathcal{L}_a + \mathcal{U}_a$, implies that $\mathcal{L}_a + \mathcal{U}_a < \mathcal{L}_a^* + \mathcal{U}_a^*$. From $\mathcal{L}_a = \theta_a m(\theta_a)\mathcal{U}_a/q$, we get

$$\mathcal{U}_a = \frac{q}{\theta_a m(\theta_a) + q} \left(\mathcal{L}_a + \mathcal{U}_a\right)$$

Since $\mathcal{L}_a + \mathcal{U}_a < \mathcal{L}_a^* + \mathcal{U}_a^*$ and $\theta_a m(\theta_a) > \theta_a^* m(\theta_a^*)$, this equation implies that $\mathcal{U}_a < \mathcal{U}_a^*$. Then, we find that this definition of $\mathcal{V}_a = \mathcal{U}_a \theta_a/\alpha$, together $\mathcal{U}_a < \mathcal{U}_a^*$ and $\theta_a^* < \theta_a$, is compatible with $\mathcal{V}_a$ either smaller or larger than $\mathcal{V}_a^*$. Similarly, this definition of

$$\mathcal{L}_a = \frac{\theta_a m(\theta_a)}{\theta_a m(\theta_a) + q} \left(\mathcal{L}_a + \mathcal{U}_a\right)$$

together with $\mathcal{L}_a + \mathcal{U}_a < \mathcal{L}_a^* + \mathcal{U}_a^*$ and and $\theta_a^* < \theta_a$ (equivalent to $\theta_a^* m(\theta_a^*) < \theta_a m(\theta_a)$) is compatible with $\mathcal{L}_a$ either smaller or larger than $\mathcal{L}_a^*$.

Finally, the comparison of the constrained efficient allocation with the decentralized equilibrium allocation when there are in-house and temp jobs in both allocations shows that

$$\begin{array}{lll} \theta_h^* \geq \theta_h; & \theta_a^* \leq \theta_a & \\ \mathcal{U}_h^* \leq \mathcal{U}_h; & \mathcal{U}_a^* \geq \mathcal{U}_a; & \mathcal{U}^* \lesseqgtr \mathcal{U} \\ \mathcal{V}_h^* \leq \mathcal{V}_h; & \mathcal{V}_a^* \lesseqgtr \mathcal{V}_a & \\ \mathcal{L}_h^* \leq \mathcal{L}_h; & \mathcal{L}_a^* \lesseqgtr \mathcal{L}_a & \mathcal{L}^* \lesseqgtr \mathcal{L} \end{array}$$

B.4.2 Allocations with in-house jobs only

Previous equations show that when there are in-house jobs only, the decentralized equilibrium coincides with the constrained efficient allocation.

B.4.3 Allocations with temp jobs only

When there are temp jobs only, the value of θ_a is defined by equation (B.34)

$$\kappa + rk = \frac{\alpha m(\theta_a)(1-\eta)}{r+q+\eta\theta_a m(\theta_a)}(y - rk - c_a - b) + \eta \frac{r+q+\theta_a m(\theta_a)}{r+q+\eta\theta_a m(\theta_a}rk$$

in decentralized equilibrium and by equation (B.38)

$$\kappa + rk = \frac{\alpha m(\theta_a^*)(1-\eta)}{r+q+\eta\theta_a^* m(\theta_a^*)}(y - rk - c_a - b)$$

in the constrained efficient allocation. For the same reasons as above, these equations imply that $\theta_a^* < \theta_a$.

The number of vacancies is defined by

$$\mathcal{V}_a^* = \mathcal{N}\frac{q\theta_a^*}{\alpha\left[q+\theta_a^* m(\theta_a^*)\right]}$$

which implies that $\mathcal{V}_a^* < \mathcal{V}_a$ if and only if $k > 0$ and the number of temp jobs is equal to

$$\mathcal{L}_a = \mathcal{V}_a\frac{\alpha m(\theta_a)}{q} = \mathcal{N}\frac{\theta_a m(\theta_a)}{[q+\theta_a m(\theta_a)]}$$

in the decentralized equilibrium and to

$$\mathcal{L}_a^* = \mathcal{N}\frac{\theta_a^* m(\theta_a^*)}{[q+\theta_a^* m(\theta_a^*)]}$$

in the constrained efficient solution.

These expressions define employment as an increasing function of the labor market tightness. Therefore, $\mathcal{L}_a^* < \mathcal{L}_a$.

B.4.4 Relation between parameter set values and types of allocation (mixed, temp only, in-house only)

Since it has been shown that $\mathcal{V}_h^* < \mathcal{V}_h$ and $\mathcal{V}_a^* \lesseqgtr \mathcal{V}_a$ in the mixed allocations, there are parameter set values for which there are temp jobs in the constrained efficient allocation but not in the decentralized equilibrium. To shows this, assume a parameter set value such that the constrained efficient solution and the decentralized equilibrium are mixed. Now, change the parameter set value so that $\mathcal{V}_h$ drops. Since $\mathcal{V}_h > \mathcal{V}_h^*$, there exist parameter set values such that the decentralized equilibrium is mixed, with low values of $\mathcal{V}_h$ sufficiently close to zero, but the constrained efficient solution cannot be mixed because $\mathcal{V}_h^* < \mathcal{V}_h$. For these parameter set values, the constrained efficient solution has temp-jobs only if it exists, because $\mathcal{V}_a \lesseqgtr \mathcal{V}_a^*$ in the mixed allocation.

Conversely, according to the same reasoning, $\mathcal{V}_h^* < \mathcal{V}_h$ implies that it is impossible to get a decentralized equilibrium with temp jobs only if the constrained efficient allocation is mixed.

All in all, the comparison of the constrained efficient allocation with the decentralized equilibrium allocation shows that:

- when there are in-house and temp jobs in both allocations:

$$\begin{array}{lll} \theta_h^* \geq \theta_h; & \theta_a^* \leq \theta_a & \\ \mathcal{U}_h^* \leq \mathcal{U}_h; & \mathcal{U}_a^* \geq \mathcal{U}_a; & \mathcal{U}^* \lesseqgtr \mathcal{U} \\ \mathcal{V}_h^* \leq \mathcal{V}_h; & \mathcal{V}_a^* \lesseqgtr \mathcal{V}_a & \\ \mathcal{L}_h^* \leq \mathcal{L}_h; & \mathcal{L}_a^* \lesseqgtr \mathcal{L}_a & \mathcal{L}^* \lesseqgtr \mathcal{L} \end{array}$$

- the allocation is identical when there are in-house jobs only in both allocations
- when there are temp jobs only in in both allocations:

$$\begin{array}{l} \theta_a^* \leq \theta_a \\ \mathcal{U}_a^* \geq \mathcal{U}_a \\ \mathcal{V}_a^* \leq \mathcal{V}_a \\ \mathcal{L}_a^* \leq \mathcal{L}_a \end{array}$$

and that there are parameter set values such that the decentralized equilibrium is mixed and the efficient allocation has temp jobs only.

B.5 Decentralized equilibrium with merged TWAs and user firms

This appendix shows that the decentralized equilibrium with merged TWAs and user firms yields the constrained efficient allocation. When TWAs and user firms are merged, user firms directly hire temp workers with the technology of TWAs. In this context, firms choose the number of in-house and temp job vacancies and the associated wages. The value function of a firm satisfies

$$(1+r\mathrm{d}t)\,\Pi\left(\mathcal{L}\right)=\max_{(\mathcal{V}_h\geq 0,\mathcal{V}_a\geq 0,w_h,w_a)}\left[y\mathcal{L}-\left(w_h+c_h\right)\mathcal{L}_h-C(\mathcal{V}_h)-\kappa\mathcal{V}_a-rk\left(\mathcal{L}+\mathcal{V}_h+\mathcal{V}_a\right)-(w_a+c_a)\mathcal{L}_a\right]\mathrm{d}t$$
$$+\Pi\left(\mathcal{L}^+\right)$$

subject to (B.21) and the law of motion of in-house and temp jobs:

$$\begin{aligned}\mathcal{L}_h^+ &= \left(1-q\mathrm{d}t\right)\mathcal{L}_h+\mathcal{V}_h m(\theta_h)\mathrm{d}t\\ \mathcal{L}_a^+ &= \left(1-q\mathrm{d}t\right)\mathcal{L}_a+\alpha\mathcal{V}_a m(\theta_a)\mathrm{d}t\end{aligned}$$

Let us denote by μ_h and μ_a the multipliers associated with the constraints $\mathcal{V}_h\geq 0,\mathcal{V}_a\geq 0$.

The offered wages satisfy

$$w_h=\eta\left(y-rk-c_h-rW_u\right)+rW_u \tag{B.44}$$

$$w_a=\eta(y-rk-c_a-rW_u)+rW_u \tag{B.45}$$

The first order conditions yield

$$-C'(\mathcal{V}_h)-rk+\Pi'\left(\mathcal{L}^+\right)m(\theta_h)+\mu_h = 0 \tag{B.46}$$
$$-\kappa-rk+\Pi'\left(\mathcal{L}^+\right)\alpha m(\theta_a)+\mu_a = 0 \tag{B.47}$$

The envelope conditions yield

$$\begin{aligned}(1+r\mathrm{d}t)\,\Pi'\left(\mathcal{L}\right) &= \left(y-rk-w_h-c_h\right)\mathrm{d}t+\left(1-q\mathrm{d}t\right)\Pi'\left(\mathcal{L}\right)\\ (1+r\mathrm{d}t)\,\Pi'\left(\mathcal{L}\right) &= \left(y-rk-w_a-c_a\right)\mathrm{d}t+\left(1-q\mathrm{d}t\right)\Pi'\left(\mathcal{L}\right)\end{aligned}$$

or

$$\Pi'\left(\mathcal{L}\right)=\frac{y-rk-w_h-c_h}{r+q}=\Pi'\left(\mathcal{L}\right)=\frac{y-rk-w_a-c_a}{r+q} \tag{B.48}$$

- Let us first consider interior solutions, with $\mu_h=\mu_a=0$. In this case, the first order conditions yield, together with the envelop condition (B.48) and the wage equations (B.44) and (B.45):

$$C'(\mathcal{V}_h)+rk=(1-\eta)m(\theta_h)\frac{y-rk-rW_u-c_h}{r+q} \tag{B.49}$$

$$\kappa+rk=\alpha m(\theta_a)\frac{y-rk-rW_u-c_a}{r+q} \tag{B.50}$$

From the arbitrage equation (B.19), the wage equations (B.44), (B.45) and the labor demand equations (B.49) and (B.50) we get the relations

$$rW_u = b + \frac{\eta\theta_a}{\alpha(1-\eta)}(\kappa + rk) \tag{B.51}$$

$$rW_u = b + \frac{\eta\theta_h}{(1-\eta)}\left[C'(\mathcal{V}) + rk\right] \tag{B.52}$$

Substituting the value of rW_u defined by equation (B.51), into the demand equation (B.50) yields:

$$\kappa + rk = \frac{\alpha m(\theta_a)(1-\eta)}{r + q + \eta\theta_a m(\theta_a)}(y - rk - c_a - b) \tag{B.53}$$

Equation (B.52) defines the expected value of unemployed workers looking for in-house jobs. From this expected value and the demand or in-house workers (B.50) we get the following equilibrium condition:

$$C'(\mathcal{V}_h) + rk = \frac{m(\theta_h)(1-\eta)}{r + q + \eta\theta_h m(\theta_h)}(y - rk - c_h - b) \tag{B.54}$$

which defines a relation between the tightness of the submarket for in-house jobs and the number of vacancies for in-house jobs.

Eventually, the equalization of the reservation wage of unemployed workers defined by equations (B.51) and (B.52) yields, together with equations (B.53) and (B.54), the relation between the labor market tighnesses arising from the arbitrage of unemployed workers between submarket

$$\frac{\theta_h m(\theta_h)(y - rk - c - b)}{r + q + \eta\theta_h m(\theta_h)} = \frac{\theta_a m(\theta_a)}{r + q + \eta\theta_a m(\theta_a)}(y - rk - c_a - b)$$

From the previous results, the equilibrium values $(\theta_a, \theta_h, \mathcal{V}_h)$ are defined by the three last equations which are identical the system of equations that defines those values at the constrained optimum.

- When firms use temp workers only, the equilibrium value of the labor market tightness if defined by equation (B.53) which is identical to equation (B.38) that defines the value of the labor market tightness at the constrained optimum

- When firms use in-house workers only, the labor market tightness is defined by equation (B.54) which is identical to that of the constrained optimum.

B.6 Implementation of the constrained efficient allocation

Let us demonstrate the implementation of a constrained efficient allocation through wage subsidies for temporary workers and taxes on vacancies posted by TWAs. Let σ_a represent the wage subsidy, such that temp workers receive the income $w_a + \sigma_a$ when TWAs pay the wage

w_a, and τ_a denotes the tax on each vacancy posted by TWAs. Solving the model as previously described yields the following equations for the wage of temporary workers and the value of vacancies posted by TWAs:

$$
\begin{aligned}
w_a + \sigma_a &= \eta \left(p - c_a + \sigma_a - rW_u\right) + rW_u \\
V_a &= \kappa - \tau_a + \alpha m(\theta_a)(1-\eta)\left(p - c_a + \sigma_a - rW_u\right)
\end{aligned}
$$

We get the set of 3 equations which define the equilibrium values of $\theta_a, \theta_h, \mathcal{V}_h$:

$$
\begin{aligned}
\kappa - \tau_a + rk &= \frac{\alpha m(\theta_a)\left(1-\eta\right)}{r+q+\eta\theta_a m(\theta_a)}\left(y - rk + \sigma_a - c_a - b\right) + \eta\frac{r+q+\theta_a m(\theta_a)}{r+q+\eta\theta_a m(\theta_a}rk \\
\frac{\theta_h m(\theta_h)\left(y - rk - c_h - b\right)}{r+q+\eta\theta_h m(\theta_h)} &= \frac{\theta_a m(\theta_a)}{r+q+\eta\theta_a m(\theta_a)}\left(y - rk + \sigma_a - c_a - b + \sigma_a - \frac{r+q}{\alpha m(\theta_a)}rk\right) \\
C'(\mathcal{V}_h) + rk &= \frac{m(\theta_h)\left(1-\eta\right)}{r+q+\eta\theta_h m(\theta_h)}\left(y - rk - c_h - b\right)
\end{aligned}
$$

The comparison of this set of equations with those defining the value of those variables at the constrained efficient optimum (equations (B.38), (B.39) and (B.40)) shows that

$$
\begin{aligned}
\sigma_a &= \frac{r+q}{\alpha m(\theta_a^*)}rk \\
\tau_a &= rk
\end{aligned}
$$

Every vacancy posted by TWAs pay the tax $\tau_a = rk$ is filled at rate $\alpha m(\theta_{ai})$. It gives rise to the discounted payment of subsidy equal to $\sigma_a/(r+q)$. Therefore, the taxes on temp job vacancies collected per unit of time are equal to the amount of subsidies paid to temp workers.

Every vacancy posted by TWAs incurs the tax $\tau_a = rk$. These vacancies are filled at a rate of $\alpha m(\theta_{ai})$. This leads to a discounted payment of subsidies, denoted by $\sigma a/(r+q)$. Consequently, the taxes collected on temporary job vacancies per unit of time equal the total amount of subsidies paid to temp workers.

B.7 Equal wages

This appendix determines the decentralized equilibrium in the presence of a regulation that mandates equal wages for temporary and in-house workers.

In this scenario, the surplus sharing rule that determines the wages of in-house workers ensures that the equality between the marginal cost of in-house vacancies and their expected profits remains unchanged from the decentralized equilibrium without the equal pay regulation:

$$
\frac{C'(\mathcal{V}_h) + rk}{m(\theta_h)} = \frac{1-\eta}{r+q+\eta\theta_h m(\theta_h)}\left(y - rk - c_h - b\right)
$$

When wages are equalized across both types of employment, workers in either job category achieve the same expected gains. According to the arbitrage equation (6) for job seekers, this implies that the job finding rates for both types of jobs are equal. Consequently, labor market tightnesses also equalize: $\theta_h = \theta_a$.

The demand from user firms for temp workers continues to be defined by the equation (10):

$$p = y - rk - rk\frac{(r+q)}{\alpha m(\theta_a)} \tag{B.55}$$

The free entry condition of TWAs implies that

$$p = w_a + c_a + \frac{\kappa(r+q)}{\alpha m(\theta_a)} \tag{B.56}$$

where

$$w_a = w_h = \eta(y - rk - c_h - rW_u) + rW_u$$

with

$$rW_u = b + \eta\theta_h m(\theta_h)\frac{y - rk - c_h - b}{r + q + \eta\theta_h m(\theta_h)}$$

Equations (B.56) and (B.55) imply that there are 2 possible cases

1. $y - rk - rk\frac{(r+q)}{\alpha m(\theta_h)} > w_h + c_a + \frac{\kappa(r+q)}{\alpha m(\theta_h)}$: the price that user firms accept to pay to use temp jobs is higher than the price compatible with the free entry condition for TWAs, which implies that there are only temp workers in equilibrium. This case arises if $w_a > w_h$ in equilibrium without implementation of the equal wage regulation

2. $y - rk - rk\frac{(r+q)}{\alpha m(\theta_h)} < w_h + c_a + \frac{\kappa(r+q)}{\alpha m(\theta_h)}$ the price that user firms accept to pay to use temp jobs is lower than the price compatible with the free entry condition for TWAs, which implies that there are only in-house workers in equilibrium. This case arises if $w_a < w_h$ in equilibrium without implementation of the equal wage regulation

C Details on the quantitative calibration

C.1 Calibration of the decentralized equilibrium from the data

To calibrate the model, we start from the vector Θ_i and the observed value of $\tilde{\varphi}_{h,i}$, $\tilde{\varphi}_{a,i}$ and dw_i respectively the measured job finding rates for in-house and TWA workers and the wage gap in level. We set $b = 0.5(y - rk)$ which corresponds to half of the value added and given a labor share of about 0.7, an unemployment benefit at around 70% of the wage. We then solve for $c_{a,i}$, $\varphi_{h,i}$ and $\varphi_{a,i}$ so that:

$$\varphi_{h,i}\frac{y_i - rk_i - c_{h,i} - b_i}{r + q_i + \eta\varphi_{h,i}} = \varphi_{a,i}\frac{y_i - rk_i - c_{a,i} - b_i - (r + q_i)rk_i\chi_{a,i}}{r + q_i + \eta\varphi_{a,i}}$$

is exactly verified and while minimizing:

$$\frac{(\varphi_{h,i} - \tilde{\varphi}_{h,i})^2}{\varphi_{h,i} + \tilde{\varphi}_{h,i}} + \frac{(\varphi_{a,i} - \tilde{\varphi}_{a,i})^2}{\varphi_{a,i} + \tilde{\varphi}_{a,i}} + \frac{(dw_i - (w_{h,i} - w_{a,i}))^2}{dw_i + (w_{h,i} - w_{a,i})}$$

where the model implied values of $w_{h,i}$, $w_{a,i}$ are defined by:

$$rWu_i = b_i + \eta\varphi_{h,i}\frac{y_i - rk_i - c_{h,i} - b_i}{r + q_i + \eta\varphi_{h,i}}$$

and

$$w_{h,i} = \eta(y_i - rk_i - c_{h,i} - rWu_i) + rWu_i \quad , \quad w_{a,i} = \eta\left(y_i - rk_i - c_{a,i} - rWu_i - (r + q_i)\frac{rk_i}{\chi_{a,i}}\right) + rWu_i$$

We keep only markets for which the observed and theoretical wage gaps are equal with a 0.1 euros margin of error. On average, we find a value of $\varphi_{a,i}$ that is lower than the measure $\tilde{\varphi}_{a,i}$ (the average difference is equal to 0.009 percentage points) and a value of $\varphi_{h,i}$ that is larger than $\tilde{\varphi}_{h,i}$ (an average difference of 0.008 percentage points). This reduces the sample to 649 markets.

From the values of $c_{a,i}$, $\varphi_{h,i}$ and $\varphi_{a,i}$, we can then solve recursively. First we define $\mathcal{V}_h$ and $\mathcal{V}_a$ to match the stationary level of employment both for in-house and TWA workers derived from the law of motions:

$$q\mathcal{L}_h = \mathcal{V}_h m(\theta_h) \quad \text{and} \quad q\mathcal{L}_a = \alpha\mathcal{V}_a m(\theta_a) \tag{C.57}$$

We then define $\mathcal{U}_h$ and $\mathcal{U}_a$ so that

$$\mathcal{U}_h = \frac{\mathcal{V}_h\chi_h}{\varphi_h} \quad \text{and} \quad \frac{\mathcal{V}_a\chi_a}{\varphi_a}$$

we can then compute the value of $\theta_h = \frac{\mathcal{V}_h}{\mathcal{U}_h}$ and combining the two equations in (C.57), we derive α as

$$\alpha = \left[\frac{ql_a}{ql}\frac{\mathcal{V}_h}{\mathcal{V}_a}\theta^{\eta}\left(\frac{\mathcal{V}_a}{\mathcal{U}_a}\right)^{\eta}\right]^{\frac{1}{1-\eta}}$$

With $\alpha, \mathcal{U}_a$ and $\mathcal{V}_a$ we immediately measure $\theta_a = \alpha\mathcal{V}_a/\mathcal{U}_a$.

We then set the value of m_0 so that the theoretical size of the market matches the observed number of workers (employed or unemployed). This implies:

$$\underbrace{\mathcal{L}_a + \mathcal{L}_h + \mathcal{U}_a + \mathcal{U}_h}_{\text{Observed}} = \underbrace{\alpha\frac{\mathcal{V}_a}{\theta_a} + \frac{\mathcal{V}}{\theta}}_{\text{Theoretical unemployment}} + \underbrace{\left(\frac{\mathcal{V}\theta^{-\eta}}{q} + \frac{\alpha\mathcal{V}_a\theta_a^{-\eta}}{q}\right)m_0}_{\text{Theoretical employment}}$$

We then estimate κ_i using

$$\kappa_i = \chi_{a,i}\frac{1-\eta}{r+q_i+\eta\varphi_{a,i}}\left(y_i - rk_i - c_{a,i} - b_i - (r_i+q_i)\frac{rk_i}{\varphi_{a,i}}\right)$$

Finally, we estimate ν and ν_0 in the following way. First we consider the third equation of (16) and log-transform the equation after having removed rk from both side. Given the functional form $C(\mathcal{V}_i)_i = \nu_{0_i}\mathcal{V}_i^{\nu}$ this yields:

$$\log(\nu_{i,0}) + \log(\nu) + \nu\log(\mathcal{V}_i) = \underbrace{\log\left(\frac{m_{0_i}\theta_{h,i}^{-\eta}(1-\eta)}{r+q_i+\eta m_{0_i}\theta_{h,i}^{1-\eta}}(y_i - rk_i - c_{h,i} - b_i)\right)}_{\equiv A_i}$$

We can then retrieve the value of ν by regressing $\log(\mathcal{V})$ on A on all our labor markets i, and then use the residuals to pin down the value of ν_{0_i}.[23]

Once all these parameters are known, it is straightforward to derive w_h, w_a and p. This procedure thus yields a unique vector $\Gamma_i = (\mathcal{V}_{h,i}, \mathcal{V}_{a,i}, \mathcal{U}_{h,i}, \mathcal{U}_{a,i}, m_{0i}, \kappa_i, c_{a,i}, \alpha_i, \theta_{h,i}, \theta_{a,i}, p_i)$ and ensures that the decentralized equilibrium matches the data perfectly.

C.2 Quantification of the social optimum

To determine the social optimum, we consider that the values $\kappa, \alpha, c_a, c_h, y, k, b, m_0, \nu, \nu_0, q$ as well as the total number of workers in the labor market (both employed and unemployed, both in-house and TWA) are the same as in the decentralized equilibrium and we want to find the optimal values for $\mathcal{V}_h^*, \mathcal{V}_a^*, \mathcal{U}_h^*, \mathcal{U}_a^*, \theta_h^*, \theta_a^*, \mathcal{L}_h^*, \mathcal{L}_a^*$ that are consistent with the equations (17) as well as the labor market tightness definitions, the flow equilibrium conditions and the fixed size of the labor market. This define 8 equations for 8 unknowns and can be solved directly.

[23]We use an IV estimator, where the value of $\mathcal{V}_h$ is instrumented by an analog taken from ForCE to mitigate measurement error bias (the average number of vacancies per firm for in-house workers).

However, one important challenge is the interior solutions presented in (17) may not be feasible and two alternative equilibrium must be considered: one with only TWA workers and one without any TWA workers. We therefore proceed as follows (see Appendix B.2.1 for more details).

To find this solution, one starts by determining $\theta_{a,i}$ from

$$\frac{\kappa + rk_i}{\alpha m_i(\theta_{a,i})} = \frac{(1-\eta)}{r + q_i + \eta\theta_{a,i} m_i(\theta_{a,i})} (y_i - c_{a,i} - b_i - rk_i)$$

where $m_i(.)$ is the matching function, specific to market i since m_0 is estimated for each market. Then, one determines θ_{hi} from the arbitrage condition:

$$\frac{\theta_{h,i} m_i(\theta_{h,i}) (y_i - c_{h,i} - b_i - rk_i)}{r + q_i + \eta\theta_{h,i} m_i(\theta_{h,i})} = \frac{\theta_{a,i} m_i(\theta_{a,i})}{r + q_i + \eta\theta_{a,i} m_i(\theta_{a,i})} (y_i - c_{a,i} - b_i - rk_i)$$

which is well defined only when

$$\frac{(y_i - c_{h,i} - b_i - rk_i)\,[r + q_i + \eta\theta_{a,i} m_i(\theta_{a,i})]}{\theta_{a,i} m(\theta_{a,i})\,(y_i - c_{a,i} - b_i - rk_i)} - \eta > 0$$

and is in this case equal to

$$\theta_{hi} = \left[\frac{m_{0_i}}{r + q_i}\left(\frac{(y_i - c_{h,i} - b_i - rk_i)\,[r + q_i + \eta\theta_{a,i} m_i(\theta_{a,i})]}{\theta_{a,i} m_i(\theta_{a,i})\,(y_i - c_{a,i} - b_i - rk_i)} - \eta\right)\right]^{\frac{1}{1-\eta}}$$

The number of vacancies for in-house workers is determined by

$$\frac{C'(\mathcal{V}_{h,i}) + rk_i}{m_i(\theta_{h,i})} = \frac{1-\eta}{r + q_i + \eta\theta_{h,i} m_i(\theta_{h,i})} (y_i - c_{h,i} - b_i - rk_i)$$

which is defined only if

$$\frac{(1-\eta)\, m(\theta_{h,ii})\,(y_i - c_{h,i} - b_i - rk_i)}{r + q_i + \eta\theta_{h,i} m_i(\theta_{h,i})} - rk_i > 0$$

and in that case is equal to:

$$\mathcal{V}_{hi} = \left[\frac{1}{\nu_{0,i}\nu}\left(\frac{(1-\eta)\, m(\theta_{h,i})\,(y_i - c_{h,i} - b_i - rk_i)}{r + q_i + \eta\theta_{h,i} m(\theta_{h,i})} - rk_i\right)\right]^{\frac{1}{\nu-1}}$$

To summarize, the constrained efficient allocation has an interior solution if and only if:

$$\begin{aligned}
\frac{(y_i - c_{h,i} - b - rk_i)\,[r + q_i + \eta\theta_{a,i} m_i(\theta_{a,i})]}{\theta_{ai} m(\theta_{ai})\,(y_i - c_{a,i} - b_u - rk_i)} - \eta &> 0 \\
\frac{(1-\eta)\, m_i(\theta_{h,i})}{r + q_i + \eta\theta_{h,i} m_i(\theta_{h,i})} (y_i - c_{h,i} - b_i - rk_i) - rk_i &> 0
\end{aligned}$$

where $\theta_{a,i}$ is defined by

$$\frac{\kappa + rk_i}{\alpha m_i(\theta_{a,i})} = \frac{(1-\eta)}{r + q_i + \eta\theta_{a,i} m_i(\theta_{a,i})} \left(y_i - c_{a,i} - b_i - rk_i\right)$$

and $\theta_{h,i}$ by the equation (using the fact that $m(\theta_{h,i}) = m_{0i}\theta_{h,i}^{-\eta}$

$$\theta_{h,i} = \left[\frac{m_{0i}}{r+q_i}\left(\frac{(y_i - c_{h,i} - b_i - rk_i)\left[r + q_i + \eta\theta_{a,i} m_i(\theta_{a,i})\right]}{\theta_{a,i} m(\theta_{a,i})\left(y_i - c_{a,i} - b_i - rk_i\right)} - \eta\right)\right]^{\frac{1}{1-\eta}}$$

If the interior solution does not exist, then one of the two alternative equilibrium should be calculated.

Solution with in-house workers only in this case the equilibrium is the same as the decentralized equilibrium. We note $C_i\prime(.)$ the cost function, specific to market i since ν_0 is estimated for each market:

$$\begin{aligned} \frac{C_i'(\mathcal{V}_{h,i}) + rk_i}{m_i(\theta_{h,i})} &= \frac{1-\eta}{r + q_i + \eta\theta_{h,i} m_i(\theta_{h,i})} \left(y_i - rk - c_{h,i} - b_i\right) \\ \frac{\mathcal{V}_{h,i}}{\theta_{h,i}} + \frac{\mathcal{V}_{h,i} m_i(\theta_{h,i})}{q_i} &= \mathcal{V}_{h,i} \frac{q_i + \theta_{h,i} m_i(\theta_{h,i})}{\theta_{h,i} q_i} = \mathcal{N}_i \end{aligned}$$

which implies that $\theta_{h,i}$ is defined by:

$$\frac{C_i'\left(\mathcal{N}_i \frac{\theta_{h,i} q_i}{q_i + \theta_{h,i} m(\theta_{h,i})}\right) + rk_i}{m_i(\theta_{h,i})} = \frac{1-\eta}{r + q_i + \eta\theta_{h,i} m_i(\theta_{h,i})} \left(y_i - rk_i - c_{h,i} - b_i\right)$$

Solution with TWA workers only

$$\frac{\kappa + rk_i}{\alpha m_i(\theta_{a,i})} = \frac{(1-\eta)}{r + q_i + \eta\theta_{ai} m(\theta_{ai})} \left(y_i - rk_i - c_{a,i} - b_i\right)$$

Welfare For each market, we calculate the welfare. We use the parameter from the interior solution when the latter is defined, and otherwise compare the two corner equilibria and consider the one with the largest welfare.

CENTRE FOR ECONOMIC PERFORMANCE
Recent Discussion Papers

2013	Richard Hornbeck Guy Michaels Ferdinand Rauch	Identifying agglomeration shadows: Long-run evidence from ancient ports
2012	Nikhil Datta	Local monopsony power
2011	Hanna Virtanen Mikko Silliman Tiina Kuuppelomäki Kristiina Huttunen	Education, gender and family formation
2010	Giorgio Barba Navaretti Matteo Bugamelli Emanuele Forlani Gianmarco I.P. Ottaviano	It takes (more than) a moment: Estimating trade flows with superstar exporters
2009	Giordano Mion Joana Silva	Trade, skills and productivity
2008	Elena Ashtari Tafti Mimosa Distefano Tetyana Surovtseva	Gender, careers and peers' gender mix
2007	Agnes Norris Keiller John Van Reenen	Disaster management
2006	Anthony Lepinteur Andrew E. Clark Conchita D'Ambrosio	Unsettled: Job insecurity reduces homeownership
2005	Ruveyda Nur Gozen	Property rights and innovation dynamism: The role of women inventors
2004	Jennifer Hunt Carolyn Moehling	Do female-owned employment agencies mitigate discrimination and expand opportunity for women?

2003	Christian A.L. Hilber Tracy M. Turner	Land use regulation, homeownership and wealth inequality
2002	Rodrigo Adão Arnaud Costinot Dave Donaldson	Putting quantitative models to the test: An application to Trump's trade war
2001	L. Rachel Ngai Claudia Olivetti Barbara Petrongolo	Gendered change: 150 years of transformation in US hours
2000	Nikhil Datta Stephen Machin	Government contracting and living wages > minimum wages
1999	Philippe Aghion Maxime Gravoueille Matthieu Lequien Stafanie Stantcheva	Tax simplicity or simplicity of evasion? Evidence from self-employment taxes in France
1998	Johannes Boehm Etienne Fize Xavier Jaravel	Five facts about MPCs: Evidence from a randomized experiment
1997	Hanwei Huang Jiandong Ju Vivian Z. Yue	Accounting for the evolution of China's production and trade patterns
1996	Carlo Altomonte Nevine El-Mallakh Tommaso Sonno	Business groups, strategic acquisitions and innovation
1995	Andrés Barrios-Fernández Marc Riudavets-Barcons	Teacher value-added and gender gaps in educational outcomes
1994	Sara Calligaris Chiara Criscuolo Luca Marcolin	Mark-ups in the digital era

The Centre for Economic Performance Publications Unit
Tel: +44 (0)20 7955 7673 Email info@cep.lse.ac.uk
Website: http://cep.lse.ac.uk Twitter: @CEP_LSE