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# The Impact of Extended Employment Protection Laws on the Demand for Temporary Agency Workers*

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**Abstract**

We study the impact of a reform that increased the regulatory burden on temporary agency work (TAW) in Chile. Using a panel of manufacturing plants, we show that the use of TAW fell immediately after the regulation, with differential effects by plants' size and volatility. Difference-in-differences estimates suggest that plants using TAW substituted away from agency workers after the regulation, increasing regular work by 9.2%. Despite this substitution effect, total employment decreased by 8.6% in these plants. We report less precise evidence of negative scale effects on output and profits.

Key Words: employment composition, employment protection legislation, temporary agency work.

JEL Classification: J21, J23

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# 1 Introduction

Labor markets are moving beyond standard work arrangements, blurring the boundaries of traditional employment. Temporary agency work (TAW), also known as temporary help jobs, is one of the most rapidly growing forms of alternative employment. Temporary agency work involves a specific type of contractual relationship in which workers are hired by an agency and temporarily assigned to work in another firm, creating a triangular relationship between the worker, the temporary agency, and the user firm. While this type of employment may offer more flexibility to firms, it is less clear what its effects are on workers. Indeed, the increasing use of TAW has not only raised public interest in the working conditions of agency workers, but has also led to the enactment of labor regulations in many countries, especially in the European Union.

Beginning with the seminal work by Saint-Paul (2002), most of the literature has focused on understanding the economic effects of dual labor markets on firms and workers, and research on temporary agency work is not an exception. Researchers have offered several reasons why firms may use TAW. These include suggestions that agency workers can provide a flexible buffer for times of uncertainty or for demand fluctuations (Houseman, 2001; Houseman et al., 2003; Jahn and Bentzen, 2010), that agency employment can be used to circumvent regulations that make labor adjustments costly (Bauman et al., 2011; Boeri, 2010, Autor, 2013), and that temporary work agencies can help user firms to screen workers (Autor, 2003). In keeping with the idea that TAW aids in the process of screening potential employees, others have suggested that TAW may be a stepping-stone into stable and regular employment (i.e. Ichino et al., 2006; Jahn and Rosholm, 2013). However, researchers have documented that agency workers have less access to training and face a higher risk of unemployment (Nienhüser and Matiaske, 2006; Autor and Houseman, 2010). An interesting study in this vein is Hirsch (2016), who shows that the job stability of non-agency workers may rise at the expense of temporary agency workers, a consequence of firms using TAW as a volatility buffer.

Although the literature has examined why firms use TAW and how TAW affects job stability for agency and non-agency workers alike, empirical evidence on the effects of tightened TAW-specific regulation is sparse, and has mainly focused on the effects of deregulation. For instance, Antoni and Jahn (2009) use administrative data to study the deregulation of the legal framework governing temporary agency work in Germany during the 90s. They find that the increase in the maximum period of assignment had a positive impact on the number of temporary help agencies, and the number of agency workers. Similarly, Autor (2003) studies the effect of state-level deregulation of temporary help services during 1973 and 1995. Using regional variation of employment protection legislation he shows that states that adopted exceptions to the "unjust dismissal" clause increased the use of temporary workers. Research on the relationship between TAW and productivity is also scarce, and seems to suggest a non-trivial relationship between the level of TAW and plant productivity. For instance, Nielsen and Schiersch (2014) find an inverted U-shaped relationship between productivity and the share of total labor costs spent on TAW, and Hirsch and Mueller (2012) report a maximum productivity effect of 14% in plants with a share of TAW of around 10%. In this context, our contribution to the existing literature is to provide evidence on the short-run effects of extending employment protection for agency workers on the demand for them and through that on plants' performance.

We study the case of Chile, a middle-income country that instituted a regulation that protects agency workers in 2007, and for which plant-level data on agency employment is available. Chile is a compelling case to study since it was a pioneer in the use of TAW as well as in its regulatory framework. The country enacted a labor law that regulates the use of TAW in the same spirit of the EU Directive (see Temporary Agency Work Directive 2008/104/EC). This law—called "Ley de Subcontratación" (Law No. 20,123)—regulated agency work for the first time in the country, thereby making user firms accountable for the legal rights of the workers hired through an employment agency. Specifically, the law made user firms jointly liable for agency workers' labor benefits such as severance payments, pension, and unemployment insurance, as well as for work-related injuries, illnesses, and fatalities. The reform also mandated that employment agencies constitute a financial guarantee on behalf of the Labor Directorate to cover the unpaid social contributions of workers hired through employment agencies.

These new legal requirements leveled conditions between regular and agency workers within the workplace, increasing the cost of using TAW *de facto*. Studying the Chilean manufacturing sector, we find strong evidence that the 2007 regulation reduced the use of TAW in both the extensive and intensive margins. Right after the regulation was enacted, the probability of using TAW decreased by 20%, and conditional on using TAW, the share of agency workers over total employment decreased by 5%. In line with existing research studying Europe and the United States,[1] we also find that larger plants facing more volatile environments rely more on TAW, and we show that the relationship between these variables and the demand for TAW became stronger after the regulation. To study the impact of this reform on plant performance, we leverage time variation around the time of the regulation and group variation between TAW-users and TAW-nonuser plants (based on their pre-reform levels of TAW use). Our main results show that plants using TAW before the regulation increased non-agency employment by 9.2% but experienced a decrease in total employ-

[1] See Abraham and Taylor (1996), Jahn and Bentzen (2010), Hirsch and Mueller (2012) and Aleksynska and Berg (2016).

ment of 8.6%. Reassuringly, plants with higher shares of agency workers —which were consequently more exposed to the regulatory change—experienced larger changes in employment. We find less precise evidence of a negative scale effect on output (ranging from -14% to -1.6%) and weaker but suggestive evidence of a negative effect on profits. Finally, we perform a series of specification checks. Results are robust to including plants' unobservable characteristics related to the decision of using agency workers (i.e., a control function approach) and also to models that account for pre-trends, either by including plant-specific time trends or lagged dependent variable.

A descriptive analysis of TAW in the Chilean manufacturing sector highlights the relevance of the 2007 regulation. As shown in Figure 1, the share of TAW increased steadily before the reform, with agency employment peaking at 12.5% of total employment in 2006. This trend broke immediately after the law was enacted, and the use of TAW decreased until it reached a plateau of around 10% in 2011. This regulation had an important impact on the extensive margin. A decomposition of the aggregate share of TAW into the share of plants using TAW, the share of TAW within firms using TAW, and the relative size of plants using TAW, shows that the percentage of plants using agency workers decreased, and the relative size of the plants that used TAW increased. Indeed, one-third of plants used TAW in 2006 whereas only one-fourth used this type of employment in 2011. We interpret this finding as evidence of an increase in the fixed costs related to the use of agency workers, although we cannot disentangle whether this increase in fixed costs purely reflects the increase in the cost of hiring from an agency or whether it is due to higher regulatory burden or bigger reputational effects for large firms.

To formally analyze the impact of the 2007 reform on the intensive and extensive margins of TAW use, we use Probit and Tobit models. We also consider a selection correction model in the spirit of Heckman (1979) to jointly estimate the effects on the extensive and intensive margins.[2] Our main specifications include years dummies to capture the timing of the reform, more than fifty sector fixed effects, and proxies for plant size and volatility. For simplicity, we define size as a dummy variable equal to one for plants with total employment (pre-reform) in the top quantile of the empirical distribution.[3] This variable is intended to capture economies of scale or frictions related to the use of TAW. As our proxy for volatility, we consider the log difference in value-added. Specifically, we use the fitted value of this difference, which we obtain from a regression of value added on input and import/export shares multiplied by the log change in prices (input prices and real exchange rate). Under the assumption that firms are price takers, our proxy for volatility should be exogenous to plant behavior, and therefore eliminates a reverse causality problem in which plants facing more volatility may demand more agency workers on one hand, while on the other hand, the use of TAW provides flexibility and reduces plants' volatility. Finally, we also add a set of control variables, including real exchange rate and its interactions with import/export shares, as well as input prices (manufacturing wage index and energy price index) interacted with the corresponding input shares.

From our Probit model, we find that the probability of using TAW decreased by 4 percentage points over a pre-reform base of 19%. Regarding the effects on the share of TAW, conditional on using agency workers, our estimates from a Tobit model suggest that total employment decreased by 1 percentage point over a pre-reform base of 20%. Both of these effects are economically and statistically significant, but the effect of the regulation is almost 4 times larger on the extensive margin. Our estimates also show a positive relationship of volatility and plant size on the extensive

[2] An indicator when a plant uses TAW in 2001 (pre-reform) is our excluded "instrument." Thus, identification is predicated upon the idea that use of agency workers in 2001 is a good predictor of TAW use in later years, but it is unrelated to the share of agency workers within a plant.

[3] All results are robust to alternative definitions of firm size, such as considering the top quartile. Table are available upon request.

and intensive margins of TAW use. Interestingly, both variables became more relevant to explain the variance in the use of agency workers after the reform. Estimates from the selection adjusted model are quantitatively and qualitatively similar, and they point out the relevance of the extensive margin effects of the Chilean regulation.

To study the impact on plant performance, we exploit the timing of the reform and whether plants are classified as TAW-users or not (based on their pre-reform levels of TAW). Pre-trends suggest that there were no significant differences between TAW-user and TAW-nonuser plants in terms of profits and non-agency employment. However, during the pre-reform period, total employment and output grew more among TAW-user plants. While the latter pattern violates the parallel trends assumption, it suggests that estimates without more controls might represent a lower bound on the effects of the reform on total employment and output. We address this threat to identification by including plant fixed effects, TAW-user specific time trends, and a control function accounting for plants' unobservable characteristics related to the decision of using agency workers. In the spirit of Card and Krueger (1994), we also estimate differential effects among TAW-user plants based on their exposure to this reform, i.e. their share of agency workers before regulation. As suggested in Angrist and Pischke (2008), we check the robustness of our results to models controlling for pre-trends either using lagged dependent variable or plant-specific trends. All specifications include the set of control variables used before: real exchange rate and its interactions with import/export shares, as well as input prices (manufacturing wage index and energy price index) interacted with the corresponding input shares.

Estimates indicate that TAW-user plants experienced a 9.2% increase in non-agency employment as a consequence of the regulation. However, their total employment decreased by 8.6%.

Consistent with this negative scale effect, we find a 5.7% decrease in output and a 1.3% decrease in profits. Estimates, including a control function to account for unobserved plant heterogeneity, show even larger effects, with total employment, output, and profits decreasing by 15%, 14%, and 5.6% respectively.[4] Reassuringly, plants with a pre-reform share of TAW above the median experienced stronger effects of this regulation. Non-agency employment increased by 22% in plants using TAW at a high intensity, and this effect is larger and statistically different than the effect of the regulation on low-intensity TAW users. Total employment also decreased by more in plants that were more exposed to the regulation. However, we do not find robust evidence of differential effects within TAW-user on output and profits. Finally, estimates from specifications that include the lagged dependent variable and firm-specific trends confirm our findings of a negative scale effect on employment (between -8 % and -6 %) and a positive substitution effect on the use of non-agency workers (between 4.8% and 6.5%). These models only provide weak evidence of such scale effects on output and profits.

The paper proceeds as follows. Section 2 describes the institutional background of the regulation and shows its aggregate effects. Section 3 describes the data used in the analysis. Section 4 is divided into two parts: in the first, we show the impact of the 2007 reform on the use of TAW, and in the second, we show the impact of this regulation on plant performance. Section 5 concludes.

## 2 The TAW regulation and its aggregate effects

Chile experienced a large growth in the number of agency workers at the turn of the twenty-first century. As a response, labor unions and politicians raised concerns about the impact of this new

[4]Interestingly, unobservables increasing the use of agency workers are negatively correlated with the use of non-agency employment and positively correlated with the level of profits made by the plants, suggesting that underlying factors increasing the benefits of using agency workers are still at play during the post-reform period, e.g. plant volatility and fixed cost to use TAW.

type of employment arrangement on workers' welfare. Public discussion led to a new regulatory framework for non-standard work arrangements. The aim of this new regulation on agency work employment, enacted in October 2006 and in force since January 2007, was to level the working conditions between agency and regular workers, similar in spirit to the European Union Directive of 2008 (Agency Work Directive 2008/104/EC).

This reform included three main changes. First, under the new law, user firms become accountable for agency workers' labor rights and the payment of their social security contributions (See Chilean Labor Code Art. 183). Indeed, user firms became jointly liable for pension and unemployment insurance contributions, as well as severance payments.[5] Second, user firms became responsible for protecting workers' safety and health in the workplace, regardless of their contractual employment status. In the case of violations of the Labor Code involving accidents or health concerns, agency workers can sue either the agency or the user firm for which they work. Third, the 2007 reform also stated that agency firms must constitute a financial guarantee on behalf of the Directorate of Labor, which can be used to cover unpaid social security contributions of agency workers in case the employment agency does not comply with its legal duties.

The law also gives user firms the right to request information from temporary employment agencies regarding their compliance with their workers' labor rights. If the agencies do not prove that they are complying with their labor regulations on time, then the user firms can withhold the appropriate amount from the agency fee to comply with agency workers' labor rights. In cases where the user firm receives a certificate demonstrating that the agency firm is fulfilling its monthly

[5] Chile has a retirement fund contribution of 10.0% of salary, an unemployment insurance contribution of 3.0%, a disability insurance contribution of 1.3%, and a severance payment system (one monthly wage per year up to 11 months). On top of the 10% contributions is the fee charged by the private Pension Fund Administrator (1%). For a complete description of the system see https://www.spensiones.cl.

labor obligations, agency workers can sue the user firm only after the prosecution of the agency has been exhausted. This provision of the law intends to mitigate the new risks faced by user firms in case the subcontractor firm does not comply with its labor regulations. Indeed, since 2007, a new industry of private consulting companies that certify labor law compliance of subcontractor firms has emerged in Chile. Local and international consulting companies like Deloitte, among others, provide these services.

Summing up, the reform increased the cost of using temporary agency workers. Aside from the potential increase on variable costs due to the full compliance of labor regulation and social security contributions, the reform also introduced an explicit fixed cost in the form of a permanent financial guarantee and a monthly certification process for employment agencies.

Importantly, labor regulation for other types of employment did not change during the period under study. Only one other reform—called “Nueva Justicia Laboral”— was enacted two years later in 2009 (see Marzán (2009) for details). This reform changed the procedures to solve labor disputes from written to oral trials and increased the number of labor courts from twenty to eighty-four to improve the enforceability of labor regulations. However, this reform made no distinction between permanent and agency workers, and therefore it should not confound the effects of TAW regulation.

The effects of the TAW regulation show up immediately in aggregate data for Chilean manufacturing plants. Figure 1 below plots the share of agency workers involved in plants’ production process in this sector by year (gray bar). We observe that the share of TAW steadily increased until 2006, when it reached 0.13, and decreased thereafter post-reform. By the end of the sample period (2011), TAWs represent only a 0.10 of plants’ total employment. Taking a closer look at the aggregate dynamics, we perform an accounting exercise that decomposes the aggregate evolution of the employment-weighted average of the percentage of agency workers in the user plants ("TAW share") around the time of the regulation, as follows:

$$\text{TAW Share} = \frac{\sum_{i \in U} TAW_i}{\sum_{i \in U}(TAW_i + R_i) + \sum_{i \notin U} R_i}$$

$$= \underbrace{\frac{\sum_{i \in U} TAW_i}{\sum_{i \in U}(TAW_i + R_i)}}_{\text{Weighted Avg. TAW Share in TAW-users}} \times \underbrace{\frac{\frac{\sum_{i \in U}(TAW_i + R_i)}{N_U}}{\frac{\sum_{i \in U}(TAW_i + R_i) + \sum_{i \notin U} R_i}{N_U + N_{-U}}}}_{\text{Rel. Size of TAW-users}} \times \underbrace{\frac{N_U}{N_U + N_{-U}}}_{\text{Share of TAW-users}} , \qquad (1)$$

where $TAW_i$ is the number of temporary agency workers and $R_i$ is the number of regular workers in plant $i$. U indicates TAW-user plants, and the terms $N_U$ and $N_{-U}$ denote the number of TAW-users (plants with $TAW_i > 0$) and TAW-nonuser (plants with $TAW_i = 0$), respectively. Equation 1 decomposes the TAW share in the manufacturing sector into three components: first, the weighted average of the share of TAW in user plants; second, the size of TAW-user plants relative to all plants in the manufacturing sector; and third, the share of TAW-user plants.

Figure 1 highlights the evolution of both the extensive (share of TAW-user plants) and the intensive margins (TAW share in TAW-users and relative size of TAW-user plants). The TAW regulation is correlated with both a decrease in the percentage of plants using agency works and an increase in the relative size of those plants. Also, in plants using TAW, the employment-weighted average TAW share decreased after 2006. Figure 1 suggests that the TAW regulation increased both the relative cost of agency workers vis-à-vis regular workers (decrease in the intensive margin) and the fixed cost of having agency workers (decrease in the number of plants using TAW and increase in the relative size of plants using them). In the following sections, we explore these data in greater depth.

## 3 Data

Our analysis is performed using data from the National Annual Manufacturers Survey (hereafter referred to by its Spanish acronym, 'ENIA') collected by the National Institute of Statistics of Chile (INE). The ENIA is an annual survey of plant-level data that encompasses all manufacturing plants with 10 or more employees and accounts for approximately half of total manufacturing employment in Chile. The survey started in 1979, but it has only recorded information on agency workers since 2001. Among the plants' characteristics, we observe the number of employees (separated between regular and agency workers), the value of raw materials used in plants' production processes, energy consumption, sales, exports, imports, output, value added, and profits. We also have plants' industry classification codes according to the International Standard Industrial Classification revision 3. Moreover, using data from 1995, we can construct a proxy for plant volatility as the standard deviation of the five lags of the log difference in value added. Appendix A presents more details about this dataset, the variable definitions, and descriptive statistics.

It is worth noting that employment data on agency workers refers to employees who perform jobs equivalent to those performed by regular workers; accordingly, we do not study wholly outsourced functions such as cleaning, food services, or security tasks. This distinction is important since it allows us to focus on workers who are close substitutes to each other, not complements who might perform different tasks within the firm, as in Goldschmidt and Schmieder (2017).

Table 1 presents the number of observations, the sample means, and the standard deviation of the main variables used in our analysis: total employment, temporary agency work, log output, and profits over nominal output. We divide the sample into four groups: plants with and without agency workers, before and after the 2007 reform. For the whole period, we have 53,846 plant-year observations, 60% in the pre-reform period and 40% in the post-reform. Plants with at least one TAW represent 18% of total observations. In the pre-reform period, 19% of firms had at least one TAW; this fell to 17% in the post-reform period.

During the post-reform period, the average plant with at least one TAW became larger relative to other plants without any TAW. Plant size, measured by total employment, increased from 60 to 65 workers for plants without TAW. For plants with at least one agency worker, the number of employees increased from 139 to 219. The difference in size between plants with and without TAW, before and after the reform, is 74 employees. These figures hold if we measure size using the log output; likewise, all these differences are statistically significant. Considering any of these measures, plants using TAW are larger than plants without TAW in the pre-reform period, and the difference in size increases during the post-reform period. The number of TAWs per plant, conditional to TAW>0, also increases from 39 to 62, a 57% increase similar to the increase in total employment per plant (conditional to TAW>0). Profits over output increased from 4% to 5.2% among plants with at least one TAW. For plants without TAW, profit decreases from 3.8% to 3.2%. Finally, we do not observe significant aggregate changes in output between these groups of plants.

Confirming previous results in the literature, our data shows a strong monotonic and positive relationship between volatility and the share of TAW. We also found a strong correlation between plant size and the use of at least one TAW. The contour diagram in Figure 2 summarizes these findings. We compute plant size as total employment and volatility as the standard deviation of the five lags of the log difference in value added.[6] We divide plant-year observations into twenty equal-sized groups (20-quantiles) by plant size and volatility.[7]

For plants in the lowest quantile of volatility, the employment-weighted average of the percentage of agency workers in the plants (TAW share) is the smallest (1%), while plants in the top quantile present the highest share of TAW (16%). Moreover, plants that show higher volatility have a higher probability of hiring at least one TAW, relative to plants that face lower volatility. This probability goes from 11% in the first quantile to 22% in the top quantile. Appendix A shows that the simple average of the TAW share is also lower in the first quantile (around 20%) than in the 20th quantile (31%) for TAW-users. All of these results are consistent with the idea that plants use TAW to cope with volatility, as has been suggested by previous research (e.g., Jahn and Bentzen, 2010; Hirsch and Mueller, 2012; Ono and Sullivan, 2013). Appendix A also shows that in the lowest quantile of plant size, the TAW share is only 1%, while in the top quantile the TAW share exceeds 13%. There is also a steep monotonic relationship between plant size and the use of at least one TAW. In the lowest quantile, only 2.6% of plants use TAW, whereas in the top quantile, more than 45% of plants use TAW. However, when focusing on the share of TAW among TAW users, we observe a U shape, without substantial differences across quantiles. We interpret these patterns as suggestive evidence of fixed costs for using agency workers. These could be fixed costs in the hiring process, higher regulatory burden for large firms due to more government supervision, or larger reputational effects.

[6]The standard deviation of log value added might capture the volatility faced by plants as well as the use of temporary agency workers (bidirectional causality). In Appendix B we propose an instrument to avoid the reverse causality between temporary agency workers and volatility. In this part we present only raw data.

[7]See Appendix A for a complete description of these results.

# 4 Impact of the TAW regulation

This section presents the main empirical analysis. First, we evaluate the effects of the 2007 reform on the extensive and intensive margins of TAW use. We provide strong evidence of a decrease in the intensive and extensive margins of agency work in the year the reform is enacted. Our analyses control for plant size and volatility, two important determinants of the use of TAW. Second, we study the impact of extended employment protection on several measures of plant performance, including total employment, output, and profits. We find that firms using TAW before the reform substituted away from agency workers towards regular employees. Nevertheless, these plants experienced negative scale effects on total employment, output, and profits.

## 4.1 Effects on TAW use

We study the effects of the 2007 labor reform on the use of TAW. Building on previous literature, we account for plant size and volatility.[8] We study both extensive and intensive margins of TAW use. Specifically, we estimate:

$$Y_{it} = \gamma_t + \mu_s + \alpha_1 \sigma_{it} + \beta_1 Size_i + \alpha_2 \sigma_{it} \times Dref + \beta_2 Size_i \times Dref + \rho' \boldsymbol{X_{it}} + v_{it}, \tag{2}$$

where $Y_{it}$ represents both a discrete variable that equals 1 if plant $i$ uses agency workers in year $t$ and a continuous variable that corresponds to the share of TAW in plant $i$ in year $t$. To estimate the effects on the former, we use a Probit model, and to assess the effects on the latter, we use a Tobit model. For simplicity, we assume that the outcome variable is a linear function of plant volatility $\sigma_{it}$ and plant size $Size_i$, and that these variables interacted with the post-reform dummy $Dref$ that equals one for all $t \geq 2007$. We divide all plant-year observations into five groups by

[8] Previous results in the literature include Abraham and Taylor (1996), Jahn and Bentzen (2010), Hirsch and Mueller (2012), Aleksynska and Berg (2016) and Jahn and Weber (2016).

size, according to their total employment in 2003, four years before the regulation. . Then, we define $Size_i$ as a dummy variable equal to one for plants in the top size quantile. To prevent any remaining omitted variable bias when estimating this model, we add year fixed effects $\gamma_t$, sector fixed effects $\mu_s$ and a set of control variables $\boldsymbol{X_{it}}$, including real exchange rate and its interactions with import/export shares, as well and input prices (manufacturing wage index and the energy price index) interacted with its input shares. [9]

It is worth noting that using variation in output as a proxy measure for volatility may give us a biased estimate of its relationship with the use of agency workers. This is because firms may use TAW to cope with volatility, but the use of TAW can also affect how output responds to shocks (given that TAW provides the flexibility to adjust). To overcome this issue of bi-directional causality, we construct an instrument for plant-level volatility. Specifically, we use the fitted value of the log difference in value-added obtained from a regression of value added on input and import/export shares multiplied by the log change in prices (input prices and real exchange rate). Under the assumption that firms are price takers, the proxy for volatility that we obtain is exogenous to plant behavior, and therefore we eliminate the reverse causality problem. Thus, we use the standard deviation calculated using five lags of the fitted value of the log difference in value added as our proxy for volatility.[10] Appendix B presents a complete description of this instrument. However, we still must control for the effect of a shock on the decision to use additional agency workers in the short-run. For example, if a firm faces an exogenous transitory positive shock, both the use of TAW and our measure of external volatility might increase in the short-run. For the volatility

[9] The national statistical institute reports the manufacturing wage index and the energy price index. The Central Bank of Chile report Chile's real exchange rate (1986=100). The energy share is the ratio between nominal expenditure in energy and nominal output. Export share is the ratio between plant exports (in pesos) and nominal output. Input imported share is the ratio between nominal imported inputs (in pesos) and nominal output.

[10] We compute: $SD(dl\hat{va}_{it}) = \left(\sum_{h=1}^{5}(dl\hat{va}_{it-h} - \overline{dl\hat{va}_{it}})^2/5\right)^{1/2}$, where $dl\hat{va}_{it}$ is the predicted value of the log change of value added. Also, notice that out proxy for volatility uses the same log difference in input prices for each plant in a given sector-year, and it also uses the same log difference of sector output price at the time-sector level.

coefficient not to capture this effect, we use the fitted value of the log difference in value added and two additional lags.

The top quantile size variable is intended to capture the economy of scale, or fixed frictions in the use of TAW. To construct this binary size proxy, we use the total employment pre-reform (in 2003) for plant size instead of the current level.[11] This avoids reverse causality between short-term demand changes and the share of TAW around its average/expected level. It accounts for additional TAW use by firms in response to a transitory positive shock. In that case, we would find a correlation between TAW use and plant size that is not related to the economy of scale in hiring or using agency workers, but with the economic cycle. We control this last effect with the two lags of the predicted log change value added.

Table 2 presents the estimation results obtained using the described proxies for volatility and plant size. Columns (1) to (3) present the estimates from the Probit model used to analyze the extensive margin. Column (1) assumes the effect of volatility and size on the probability to use at least one TAW does not change with the reform. Under this assumption, the reform only affects year-dummies. One standard deviation in our measure of volatility (0.02) increases the probability to use at least one TAW by 0.8 percentage point, an economically significant impact if we consider that in the sample only 11% of plants use TAW in a given year in the pre-reform era. Regarding plant-size effect, the coefficient on the top-size dummy has the expected sign, with larger plants having a higher probability of using agency workers. The marginal effect of moving to the top quantile, computed at the mean value of variables, is 14 percentage points.

[11] We classify plants that enter to the sample post 2003 as small (size dummy equals to 0). Results are robust to exclude new entrants post 2003, and to alternative definitions of firm size, such as considering the top quartile instead of top quantile. Tables are available upon request.

Columns (2) and (3) interact volatility and size proxy with a reform dummy ($t \geq 2007$). The main effect of volatility and its interaction with the post-reform period have the expected positive sign. The joint significance test rejects the hypothesis that both volatility terms are equal to 0 at 1%, but the coefficients are not independently significant at standard levels. It is interesting to note that after the reform, the marginal effect of moving to the group of larger plants increases from 13.4 to 15.9 percentage points. This result is consistent with the idea that the 2007 reform increased the fixed costs of using TAW, with the greatest effect on plants at the margin between using TAW or not. Size becomes a more important determinant of TAW.

Columns (4) to (6) show the results from the Tobit model used to study the intensive margin. Under the assumption that the effect of volatility and size on the share does not change after the reform, Column (4) shows that the conditional mean marginal effect of a one percent increase in plant volatility is 0.4 percentage points. This effect is statistically significant given a pre-reform TAW share of 20 percentage points, among plants who use TAW. Columns (5) and (6) allow for a heterogeneous effect of volatility pre and post-reform. Volatility interacted with the post-reform dummy is not statistically different from 0 at standard levels. The effect of the reform on plants facing different levels of volatility is not obvious. Under the assumption that plants use TAW to deal with volatility and to circumvent labor regulations, the post-reform coefficient should be positive if there is no a correlation between the use of TAW to deal with volatility and to circumvent volatility. However, it could be negative if this correlation is positive. Column (4) also shows that the average (pre and post-reform) marginal effect of moving towards the largest group of plants on the TAW share is 4.1 percentage points. Allowing for heterogeneous effects pre and post-reform, Columns (5) and (6) show the size effect increases from 3.7 to 4.6 percentage points after the reform.

Figure 3 plots the coefficient on the year dummies controls used in both models, columns (2) and (4). Panel A and B show, respectively, the estimated coefficients for the extensive and intensive margins of TAW use. Relative to the pre-reform years, the average marginal effect on the probability of using TAW fell by 3.7 percentage points in 2007, when the reform was enacted, a statistically significant 16% decrease with respect to the pre-reform base of 19 percentage points. Similarly, conditional to use of TAW, the marginal effect on the share of TAW decreased by 1 percentage point over a pre-reform base of 21%.

Finally, in Table 3 we present the effects of the reform on the extensive and intensive margin, estimated jointly, using a selection model á la Heckman (1979). A dummy that takes value 1 when the plant uses TAW in 2001 (pre-reform) is our excluded variable for the selection model. Identification is predicated upon the idea that use of agency workers in 2001 is a good predictor of TAW use in later years, but it is unrelated to the share of agency workers within a plant.[12] Under the assumption that the effect of volatility and size on TAW does not change post-reform, columns (1) and (4) highlight the role of plant volatility on both extensive and intensive margins, and they also confirm the relationship between plant size and use of TAW. Interestingly, this two-level model shows no effect of plant size on the share of TAW. Regarding the differential effects of the 2007 labor regulation, columns (2), (3), (5) and (6) suggest that volatility and plant size became more important determinants of the use of at least agency workers (with a t stat of 1.5 for the size coefficient), but do not affect the intensive margin.

In sum, these results confirm previous findings of the role of plant volatility and plant size on the use of agency workers. More important, this section shows an economically important and

[12]To avoid mechanical correlation in the selection equation, we exclude the years 2001 and 2002 from the analysis.

statistically significant effect of the 2007 reform on the intensive and extensive margin.

### 4.2 Effects on plant performance

We now consider the effects of the regulation on plant-level performance. We begin comparing pre- and post-reform outcomes between treated plants, i.e. plants that used agency workers before the reform, vis-à-vis plants that did not use them. We start by presenting an event-study to visually gauge the extent to which our definition of treatment could confound the results from the difference in differences approach. Specifically, we estimate:

$$Y_{it} = \alpha_i + \gamma_t + \sum_{s=2002}^{2011} \beta_s \left( DTAW_{iPreRef} \times Year_s \right) + \rho' \boldsymbol{X_{it}} + \epsilon_{it}, \quad (3)$$

where $\beta_s$ coefficients capture the year-by-year difference in the outcome variable $Y_{it}$ between plants that used agency workers in 2006 ($DTAW_{iPreRef} = 1$) and plants that did not use them ($DTAW_{iPreRef} = 0$). This specification includes plant and year fixed effects as well as price controls, and, as mentioned before, it allows us to check the identification assumptions underlying our main difference in difference approach. For instance, if we observed that plants using TAW before the reform were also decreasing total employment (relative to non-users of TAW), then we would consider that a negative effect on total employment for TAW-user plants simply reflects differences in pre-trends between these two groups of plants instead of the effect of the reform. Figure 3 plots the point estimates and 95% confidence intervals for these $\beta_s$ coefficients, where 2006 is the omitted year category. We focus on four outcome variables: log non-TAW employment, log total employment, log output, and the inverse hyperbolic arcsine of profits.[13]

Panel A shows a remarkable effect of the reform on the number of non-agency workers, which

[13] We use the inverse hyperbolic arcsine function since it approximates the natural logarithm of profits (which may be positive and negative) and it also allows retaining zero-valued observations.

increased by 8.5% immediately after the reform. This shift towards non-agency workers constitutes a permanent effect of the regulation on TAW-user plants. Panels B and C present the evolution of total employment and output in TAW user plants relative to non-users. These figures show that, before extending the employment protection to agency workers, total employment and output were growing in TAW-user plants. After the reform, however, this trend broke and both outcomes decreased. It is worth noting that this pre-trend may suggest that our difference in difference approach underestimates the effects of the reform on total employment and output.[14] Finally, Panel D plots our estimates for the hyperbolic arcsine of plant profit. In this case we do not see clear evidence of pre-trends or immediate effects of the regulation on TAW.

To address potential identification concerns raised by the pre-trends in total employment and output, we proceed in several ways. First, we account for TAW-specific trends and enhance our model with a control function approach. Second, we study differential effects within TAW-user plants; and finally, we estimate models with lagged dependent variable and plant-specific trends. We begin with the following baseline model:

$$Y_{it} = \alpha_i + \gamma_t + \beta_1 \left( DTAW_{iPreRef} \times t \right) + \beta_2 \left( DTAW_{iPreRef} \times Dref \right) + \rho' \boldsymbol{X_{it}} + \epsilon_{it}, \qquad (4)$$

where $Y_{it}$ represents the outcome variable in plant $i$ at time $t$, $Dref$ is a post-reform dummy equal to one for all $t \geq 2007$, and $DTAW_{iPreRef}$ is a binary variable equal to 1 if the plant used TAW before the reform in 2006 and zero otherwise. We account by selection on time invariant characteristics by including plant fixed effects $\alpha_i$, and following the results from the event study,

[14] A first order approximation for the counterfactual evolution of total employment and output in TAW-user plants would indicate that, in absence of the reform, these plants should have kept experiencing growth.

we also allow TAW-user plants to have a specific time trend $DTAW_{iPreRef} \times t$. This specification includes year fixed effects to account for the economic cycle and a set of additional variables $\boldsymbol{X_{it}}$ that control for changes in the real exchange rate and input prices, including the manufacturing wage index and the energy price index. We interact these variables with the plants' labor share, energy shares, export shares, and input imported shares, respectively.

Furthermore, since the classification of TAW-user plants ($DTAW_{iPreRef}$) could induce bias in non-trivial ways (e.g. the use of TAW might make plants more prone to mean reversion), we enhance the model with a semi-parametric approach to account for unobservable characteristics influencing a plant's decision to use TAW. Specifically, we model the decision to use TAW pre-reform as follows:

$$DTAW^*_{iPreRef} = \psi(\boldsymbol{Z_i}) + \epsilon_i$$

$$DTAW_{iPreRef} = \begin{cases} 1 \text{ if} & -\psi(\boldsymbol{Z_i}) < \epsilon_i \\ 0 \text{ if} & -\psi(\boldsymbol{Z_i}) \geq \epsilon_i \end{cases},$$

where the observed choice $DTAW_{iPreRef}$ depends on a latent variable $DTAW^*_{iPreRef}$ describing the benefits of using TAW. This heckit model requires a variable vector $\boldsymbol{Z_i}$ that shifs the decision of using TAW in the pre-reform period. We define $\boldsymbol{Z_i}$ as a vector that includes the price controls $\boldsymbol{X_{it}}$ and an indicator for whether a plant was using TAW at the beginning of our sample period, in 2001. In this setting, identification will be achieved under the assumption that the use of TAW in 2001 works as a good predictor for the use of TAW in 2006, which should be true if the effect of transitory shocks on the use of agency workers dissipates "soon enough," i.e. $\epsilon_{i2001} \perp \epsilon_{i2006}$. Finally, as in Heckman (1979), we assume that the plant-level heterogeneity term $\epsilon_i$ is drawn from a normal distribution $\epsilon_i \mid \boldsymbol{Z_i} \sim N(\mu, \sigma)$.[15] Under the latter assumption, we can recover the $E[\epsilon_i \mid \boldsymbol{Z_i}, DTAW_i]$ from a Probit specification for $DTAW_{iPreRef}$ to estimate the following model:

$$\begin{aligned} Y_{it} = \; & \alpha_i + \gamma_t + \beta_1 \left(DTAW_{iPreRef} \times t\right) + \beta_2 \left(DTAW_{iPreRef} \times Dref\right) + \rho' \boldsymbol{X_{it}} \\ & + \rho_2 \left(\lambda^{TAW}(\boldsymbol{Z_i}) \times Dref\right) + v_{it}, \end{aligned} \tag{5}$$

where $\lambda^{TAW}(\boldsymbol{Z_i})$ is the generalized residual from the Probit model (i.e. the Mills ratio) interacted with a post-reform dummy. If well-specified, this control-function approach should remove the part of the variation in $DTAW_{iPreRef}$ that is correlated with the error term $\epsilon_i$, guaranteeing that the OLS projection of the outcome on $DTAW_{iPreRef}$ is consistent. The results from this difference in differences approach, including the control function, are presented in Table 4.

Estimates from our baseline model indicate that TAW-user plants experienced a 9.2% increase in non-agency employment because of the regulation. Nevertheless, total employment decreased by 8.6% in this group of plants. Consistent with the negative scale effect, our results also show negative effects on output and profits.[16] Specifically, we estimate a 5.7% decrease in output and a 1.3% decrease in plant profits. Estimates accounting for unobserved plant heterogeneity show even larger effects, with total employment, output, and profits decreasing by 15%, 14%, and 5.6% respectively. Interestingly, the unobservables increasing the use of agency workers are negatively correlated with the use of non-agency employment and positively correlated with the level of profits made by the plants, suggesting that underlying factors increasing the benefits of using agency workers are still at play during the post-reform period, e.g. plant volatility and fixed cost to use TAW.

[15] It is also worth noting that identification in this context also requires assuming linear dependence of mean potential outcomes on the unobservable that influence the choice.

[16] As discussed in Bellemare and Wichman (2018), the small-sample bias corrected approximation of a percentage change in profits associated to the discrete change in $DTAW_{iPreRef} \times Dref$ is given by $\exp(\hat{\beta} - 0.5 \times Var(\hat{\beta})) - 1$.

While the previous model distinguishes between TAW user and non-user plants, it does not control for the intensity of use of agency workers. In the spirit of Card and Krueger (1994), we estimate the following model to exploit variation in the intensive and extensive margins:

$$\begin{aligned} Y_{it} = \quad & \beta_1 \left( DTAW^{High\%}_{iPreRef} \times t \right) + \beta_2 \left( DTAW^{Low\%}_{iPreRef} \times t \right) \\ & + \beta_3 \left( DTAW^{High\%}_{iPreRef} \times Dref \right) + \beta_4 \left( DTAW^{Low\%}_{iPreRef} \times Dref \right) \\ & + \alpha_i + \gamma_t + \rho' \boldsymbol{X_{it}} + \epsilon_{it}, \end{aligned} \tag{6}$$

where the coefficients on $\beta_3$ and $\beta_4$ capture the differential effect of the reform on plants with a high and low share of TAW (above/below median), relative to the baseline of not using TAW before the reform.[17] This specification is helpful in two ways. First, it allows us to study the effects of the reform among groups exposed to different intensities of treatment. Second, it allows us to confirm that the source of variation used for identification comes from the reform. In other words, if previous estimates are really driven by the regulation on TAW, then we should expect stronger effects on plants that were using a larger share of TAW before the reform. Table 5 presents these results.

As expected, all the effects in high and low-intensity users are jointly significant at standard levels. Reassuringly, plants with higher shares of TAW experienced a larger increase in the number of non-agency workers. According to our baseline specification, non-agency employment increased by 22% in plants using TAW with high intensity (pre-reform share of TAW above the median). This effect is larger and statistically different than the effect of the regulation on low-intensity TAW users. In line with our previous results, we also observe differential effects on total employment,

[17] Although this framework is easily extensible to more quantiles, we split the sample of $DTAW_{iPreRef} = 1$ into just two groups (above and below the median) to maximize power, given the reduced number of observations within $DTAW_{iPreRef} = 1$ (approximately 1000 plants in each group, as of 2006).

which decreased by more in plants that used more agency workers before the regulation. These differential effects on employment are also statistically different at standard levels, i.e. we reject the null of equal coefficients among TAW-users. However, we do not find robust evidence of differential effects on output and profits: we cannot reject the null that the effects are non-statistically different among high and low-intensity TAW-users, although the effect on profit exhibits the expected sign.

For a final robustness check, we consider a model in first differences that include lagged dependent variables and a model with a plant-specific time trend. As suggested in Angrist and Pischke (2009), we estimate a model in first differences that includes lagged dependent variables and plant fixed effects to control for pre-trends. Specifically, we are interested in the following model:

$$Y_{it} = \alpha_i + \gamma_t + \theta Y_{it-1} + \beta_1 \left(DTAW_{iPreRef} \times t\right) + \beta_2 \left(DTAW_{iPreRef} \times Dref\right) + \rho' \boldsymbol{X_{it}} + \epsilon_{it},$$

where $Y_{it-1}$ represents the first lag of the outcome variable. After taking first differences and instrumenting $\Delta Y_{it-1}$ with $\Delta Y_{it-2}$ (since $\Delta Y_{it-1}$ is mechanically correlated with $\Delta \epsilon_{it}$) we estimate:

$$\Delta Y_{it} = \alpha_i + \gamma_t + \theta \Delta Y_{it-1} + \beta_1 \left(DTAW_{iPreRef}\right) + \beta_2 \left(DTAW_{iPreRef} \times \Delta Dref\right) + \rho' \Delta \boldsymbol{X_{it}} + \Delta \epsilon_{it} \quad (7)$$

Moreover, we also estimate a model with plant-specific time trend, which allows the effect of unobservables on plant performance to change over time, as follows:

$$Y_{it} = \alpha_i + \gamma_t + \alpha_i \times t + \beta \left(DTAW_{iPreRef} \times Dref\right) + \rho' \boldsymbol{X_{it}} + \epsilon_{it},$$

where $\alpha_i$ controls for time invariant plant characteristics and $\alpha_i \times t$ controls by time variant plant characteristics. To estimate this model, we take the first difference to obtain:

$$\Delta Y_{it} = \gamma_i + \mu_i + \beta \left( DTAW_{iPreRef} \times \Delta Dref \right) + \rho' \boldsymbol{\Delta X_{it}} + \Delta \epsilon_{it}, \tag{8}$$

which can be estimated including plant fixed effects. It is important to notice that this model exploits variation in the contiguous pre and post-reform year, i.e. $\Delta Dref = 1$ only in 2007.

Table 6 presents estimates from both models described before. The odd number columns show the results from the model with lagged dependent variable, and the even number columns show the estimates from the plant-specific trend model. Results confirm that, despite a substitution effect towards regular employees, the reform had negative effects on total employment. Estimates suggest a negative effect on employment between 6 and 8 % and a positive effect on the use of non-agency workers between 4.8 and 6.5 %. However, we only find weak evidence of such a scale effect on output and profits. An important consideration noticed by Gorodnichenko and Sabrianova (2007) is that applying fixed effects to a differenced equation not only tends to magnify standard errors due to a smaller sample size, but also reduces residual variation in the regressors, thereby increasing the variation of the error term, which might create attenuation bias due to an increase in the noise-to-signal ratio. This may explain why the size of the effects becomes smaller in magnitude, with the effects on profits and output becoming statistically nonsignificant at standard levels.

## 5 Conclusion

During the past decades, countries have witnessed rapid growth in the number of people engaged in alternative work arrangements. Here, we have studied one of the most prominent non-standard work arrangements: temporary agency work, also known as temporary help jobs. The nature of this type of employment is controversial. On one hand, some argue that temporary agency jobs allow firms to cope with volatility while helping workers to get experience and reach more stable employment. On the other hand, temporary agency employment is seen as a trap, a strategy used by employers to circumvent labor regulations protecting workers' rights. Reflecting on these concerns and responding to the rising importance of new forms of labor, countries have enacted new regulations that aim to balance flexibility and security in the labor market.

In this paper, we provide novel evidence on the economic effects of extending employment protection to agency workers. We find that the increase in costs prompted by the TAW regulation decreased the probability of using agency workers by 15%. Moreover, the regulation strengthened the relationship between TAW use, plant size, and plant volatility. Regarding the effects on plant performance, we find evidence of both scale and substitution effects. Despite the increase in the use of non-TAW employment among TAW-user plants during the post-reform, their total employment decreased in an economically and statistically significant way. Consistent with this negative scale effect on employment, we find suggestive evidence that the regulation resonated negatively on output and profits, although these latter effects are not robust across all specifications.

In a final note, is worth highlighting that although we estimate a negative effect of this reform on total employment, our study is silent about the effects of this regulation on total welfare. Unfortunately, data limitations do not allow us to study the effects that this reform had on workers, an economically important and policy-relevant question that we hope to address in future work.

## References

[1] Abraham, K. G., and S. K. Taylor (1996): "Firms' use of outside contractors: Theory and evidence," *Journal of Labor Economics*, 14(3), 394–424.

[2] Aleksynska, M., J. Berg, et al. (2016): "Firms' demand for temporary labour in developing countries: necessity or strategy?," Discussion paper, International Labour Organization.

[3] Angrist, J. D., and J.-S. Pischke (2008): *Mostly harmless econometrics: An empiricist's companion*. Princeton university press.

[4] Antoni, M., and E. J. Jahn (2009): "Do changes in regulation affect employment duration in temporary help agencies?," *ILR Review*, 62(2), 226–251.

[5] Autor, D. H. (2001): "Why do temporary help firms provide free general skills training?," *The Quarterly Journal of Economics*, 116(4), 1409–1448.

[6] ——— (2003): "Outsourcing at will: The contribution of unjust dismissal doctrine to the growth of employment outsourcing," *Journal of labor economics*, 21(1), 1–42.

[7] Autor, D. H., and S. N. Houseman (2010): "Do Temporary-Help Jobs Improve Labor Market Outcomes for Low-Skilled Workers? Evidence from" Work First"," *American Economic Journal: Applied Economics*, pp. 96–128.

[8] Baumann, F., M. Mechtel, and N. Stähler (2011): "Employment protection and temporary work agencies," *Labour*, 25(3), 308–329.

[9] Boeri, T. (2010): "Institutional reforms in European labour markets," *Handbook of Labour Economics*, 4, 1173–236.

[10] CARD, D., AND A. B. KRUEGER (1994): "Minimum Wages and Employment: A Case Study of the Fast-Food Industry in New Jersey and Pennsylvania," *The American Economic Review*, 84(4), 772–793.

[11] GOLDSCHMIDT, D., AND J. F. SCHMIEDER (2017): "The rise of domestic outsourcing and the evolution of the German wage structure," *The Quarterly Journal of Economics*, 132(3), 1165–1217.

[12] GORODNICHENKO, Y., AND K. S. PETER (2007): "Public sector pay and corruption: Measuring bribery from micro data," *Journal of Public economics*, 91(5-6), 963–991.

[13] HECKMAN, J. (1979): "Sample selection bias as a specification error," *Econometrica*, 47, 153–161.

[14] HIRSCH, B. (2016): "Dual labor markets at work: The impact of employers' use of temporary agency work on regular workers' job stability," *ILR Review*, 69(5), 1191–1215.

[15] HIRSCH, B., AND S. MUELLER (2012a): "The productivity effect of temporary agency work: Evidence from German panel data," *The Economic Journal*, 122(562).

[16] ——— (2012b): "The productivity effect of temporary agency work: Evidence from German panel data," *The Economic Journal*, 122(562), F216–F235.

[17] HOUSEMAN, S. N. (2001): "Why employers use flexible staffing arrangements: Evidence from an establishment survey," *ILR Review*, 55(1), 149–170.

[18] ——— (2014): "Temporary agency work," *IZA World of Labor*.

[19] HOUSEMAN, S. N., A. L. KALLEBERG, AND G. A. ERICKCEK (2003): "The role of temporary agency employment in tight labor markets," *ILR Review*, 57(1), 105–127.

[20] ICHINO, A., F. MEALLI, AND T. NANNICINI (2008): "From temporary help jobs to permanent employment: What can we learn from matching estimators and their sensitivity?," *Journal of Applied Econometrics*, 23(3), 305–327.

[21] JAHN, E., AND M. ROSHOLM (2013): "Is temporary agency employment a stepping stone for immigrants?," *Economics Letters*, 118(1), 225–228.

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

[23] ——— (2016b): "The effect of temporary help jobs on employment volatility," *Canadian Journal of Economics/Revue canadienne d'économique*, 49(1), 412–427.

[24] Jahn, E. J., and J. Bentzen (2012): "What drives the demand for temporary agency workers?," *Labour*, 26(3), 341–355.

[25] Marzán, C. F. R. (2009): "Of Labor Inspectors and Judges: Chilean Labor Law Enforcement After Pinochet (and What the United States Can Do to Help)," *. Louis ULJ*, 54, 497.

[26] Neugart, M., and D. Storrie (2006): "The emergence of temporary work agencies," *Oxford Economic Papers*, 58(1), 137–156.

[27] Nielen, S., and A. Schiersch (2011): "Temporary Agency Work and Firm Competitiveness: Evidence from a panel data set of German manufacturing enterprises," Discussion paper, Schumpeter Discussion Papers.

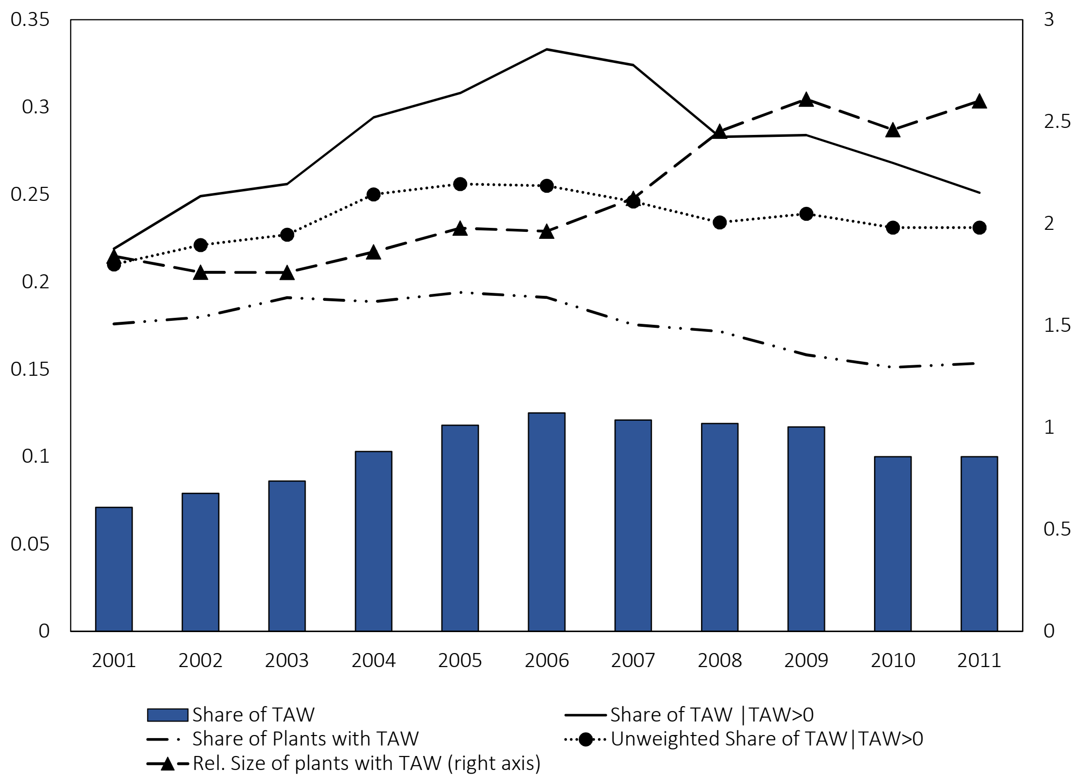
[28] Nienhüser, W., and W. Matiaske (2006): "Effects of the 'principle of non-discrimination'on temporary agency work: compensation and working conditions of temporary agency workers in 15 European countries," *Industrial Relations Journal*, 37(1), 64–77.

[29] Ono, Y., and D. Sullivan (2013): "Manufacturing plants' use of temporary workers: An analysis using census microdata," *Industrial Relations: A Journal of Economy and Society*, 52(2), 419–443.

[30] Saint Paul, G. (2002): "Employment protection, international specialization and innovation," *European Economic Review*, 46(2), 375–395.

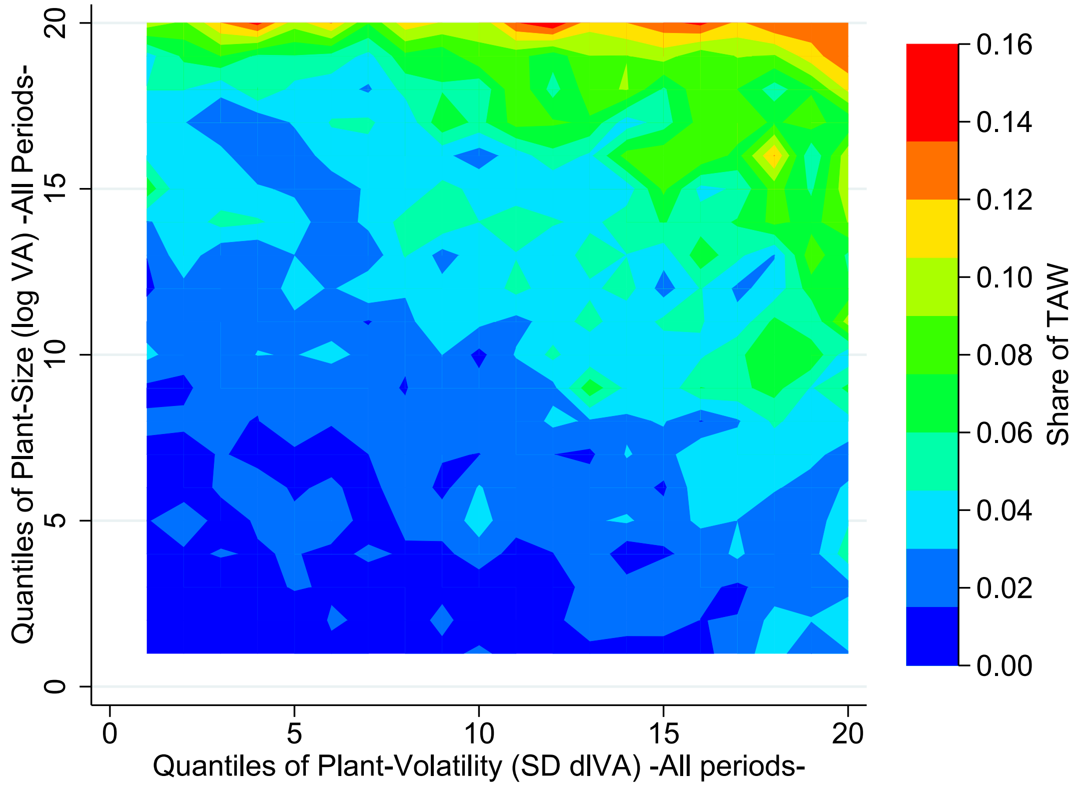
# Figures and Tables

Figure 1: Share of TAW decomposition




Note: This figure decomposes the aggregate evolution of the TAW share, following Equation [1]. Share of TAW corresponds to the sum of temporary agency workers divided by total employment in manufacturing. Share of Plants with TAW is defined as the sum of all plants with at least one TAW over the total number of plants in a given year. Rel. Size of plants with TAW is the simple average of the number of employees in plants with at least one TAW over the simple average considering all plants in manufacturing. Share of TAW |TAW>0 and Unweighted Share of TAW |TAW>0 correspond to the sum all TAW divided by total employment in plants with at least one TAW, the former weighted by the number of employees and the latter unweighted.
Source: Authors' construction using ENIA.

Figure 2: Share of TAW and plant characteristics

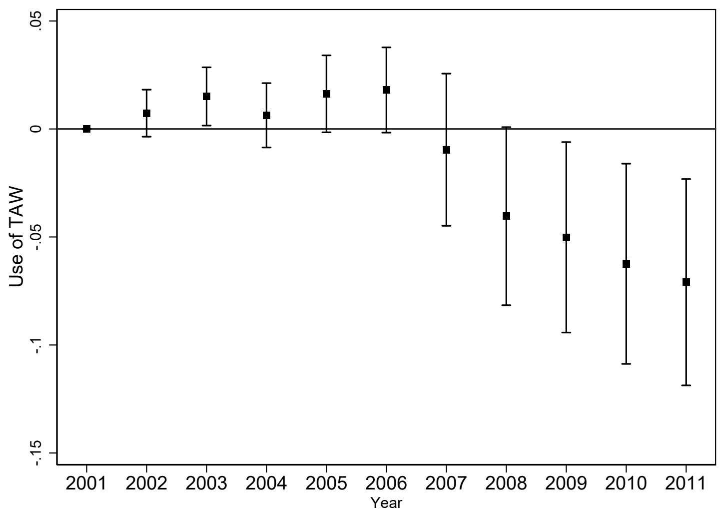



Note: This figure shows the relationship between the Share of TAW and two plant characteristics: Plant-Size and Plant-Volatility. We use the 5-year standard deviation of the log change of value added as proxy for plant volatility and the log of total employment for plant size.

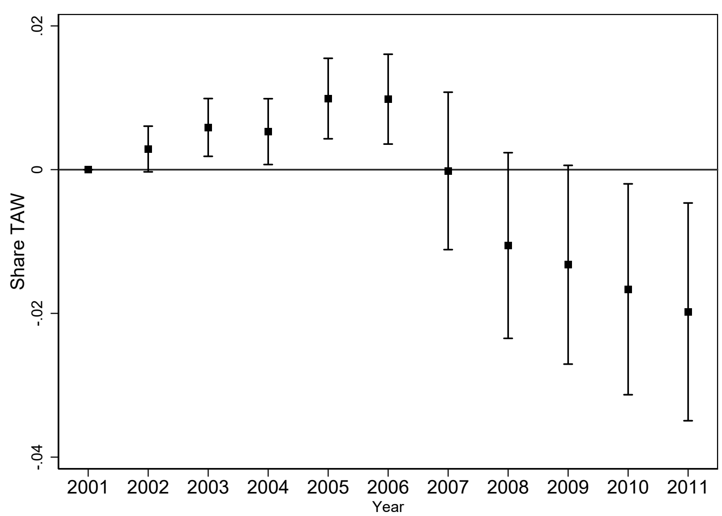
Source: Authors' construction using ENIA.

Figure 3: Year coefficients

Panel A: Probit model



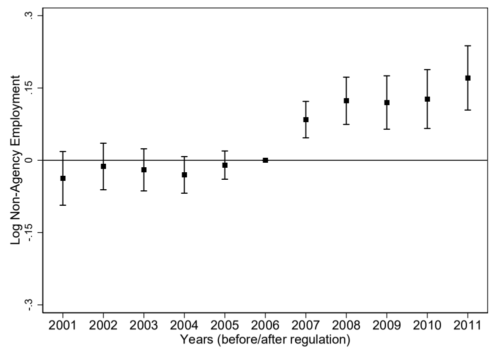

Panel B: Tobit model



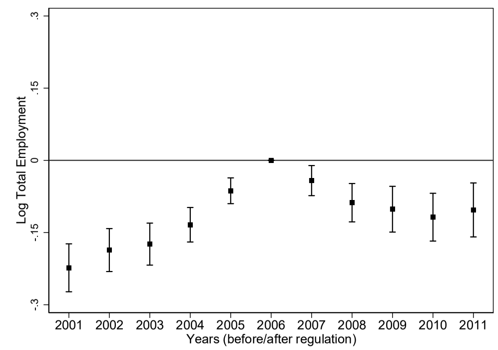

Note: These figures plot the year coefficients from the probit and tobit model reported in Table 2 columns (1) and (3). These coefficients correspond to the average marginal effect in the Probit model and to the average marginal effects on the truncated expected value of the TAW share in the Tobit model. Confidence intervals at 95% confidence level, using robust standard errors clustered at the plant level.

Figure 4: Year by Year Coefficients

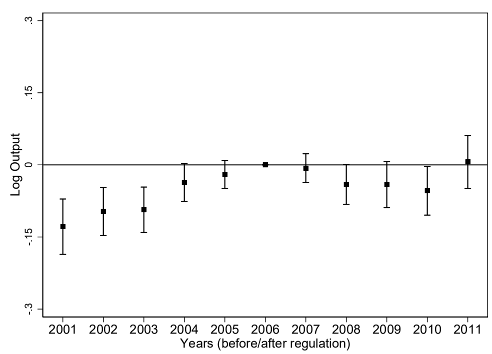
Panel A: Log non-agency Employment



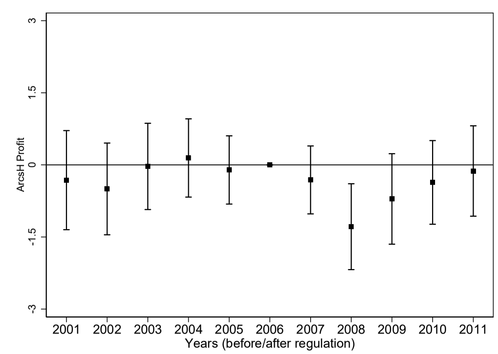

Panel B: Log Total Employment




Panel C: Log Output




Panel D: Hyperbolic Arcsine of Profits




Note: These figures plot the $\beta_s$ coefficients from the interaction between using TAW before the reform and year dummies, as presented in Equation [3]. All models include controls for input prices interacted with input shares and nominal exchange rate multiplied by export share and imported input share. We also include year and plant fixed effects. Confidence intervals at 95% confidence level, using robust standard errors clustered at the plant level.

Table 1: Summary Statistics

| Group | Observations | Total Employment | Total TAW | Log Output | Profits (% Output) |
|---|---|---|---|---|---|
| TAW=0, 2001-2006 | 26,075 | 59.7 | - | 12.9 | 4 |
| | | (139.8) | - | (1.8) | (20) |
| TAW=0, 2007-2011 | 18,231 | 65 | - | 13.2 | 5.2 |
| | | (144.1) | - | (1.8) | (10) |
| TAW>0, 2001-2006 | 5,992 | 139.4 | 39.3 | 14 | 3.8 |
| | | (255.3) | (129.9) | (1.8) | (10) |
| TAW>0, 2007-2011 | 3,548 | 218.6 | 62 | 14.8 | 3.2 |
| | | (381.8) | (185.2) | (1.9) | (10) |

Note: This table presents the sample mean and standard deviation (in parenthesis) for plants with and without TAW, before and after the reform. Our measure of profits as a percentage of output excludes the 1% of extreme values. Source: Authors' construction using ENIA.

Table 2: Use of TAW: Probit and Tobit

| | Probit I(TAW>0) | | | Tobit %TAW | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Volatility (Proxy) | 0.474*** | 0.503*** | 0.065 | 0.171*** | 0.171*** | 0.042 |
| | (0.109) | (0.146) | (0.156) | (0.052) | (0.045) | (0.049) |
| Size (Above p75) | 0.144*** | 0.134*** | 0.127*** | 0.041*** | 0.037*** | 0.035*** |
| | (0.005) | (0.006) | (0.006) | (0.003) | (0.002) | (0.002) |
| Volatility × DRef | | -0.027 | 0.365* | | 0.012 | 0.130* |
| | | (0.219) | (0.221) | | (0.069) | (0.070) |
| Size × DRef | | 0.025** | 0.021** | | 0.008*** | 0.008*** |
| | | (0.010) | (0.010) | | (0.003) | (0.003) |
| Year 2002 | 0.007 | 0.007 | 0.005 | 0.003* | 0.003 | 0.002 |
| | (0.009) | (0.009) | (0.009) | (0.002) | (0.003) | (0.003) |
| Year 2003 | 0.015 | 0.015 | 0.010 | 0.006*** | 0.006** | 0.004 |
| | (0.009) | (0.009) | (0.009) | (0.002) | (0.003) | (0.003) |
| Year 2004 | 0.006 | 0.006 | 0.004 | 0.005** | 0.005* | 0.004 |
| | (0.009) | (0.009) | (0.009) | (0.002) | (0.003) | (0.003) |
| Year 2005 | 0.014 | 0.016* | 0.006 | 0.009*** | 0.010*** | 0.006** |
| | (0.010) | (0.010) | (0.010) | (0.003) | (0.003) | (0.003) |
| Year 2006 | 0.016 | 0.018* | 0.005 | 0.009*** | 0.010*** | 0.005* |
| | (0.010) | (0.010) | (0.010) | (0.003) | (0.003) | (0.003) |
| Year 2007 | -0.006 | -0.010 | -0.036** | 0.002 | -0.000 | -0.009* |
| | (0.010) | (0.015) | (0.015) | (0.003) | (0.005) | (0.005) |
| Year 2008 | -0.037*** | -0.040** | -0.066*** | -0.008** | -0.011** | -0.019*** |
| | (0.011) | (0.017) | (0.017) | (0.004) | (0.005) | (0.005) |
| Year 2009 | -0.047*** | -0.050*** | -0.074*** | -0.011*** | -0.013** | -0.021*** |
| | (0.011) | (0.018) | (0.019) | (0.004) | (0.006) | (0.006) |
| Year 2010 | -0.060*** | -0.062*** | -0.087*** | -0.014*** | -0.017*** | -0.025*** |
| | (0.012) | (0.019) | (0.020) | (0.004) | (0.006) | (0.006) |
| Year 2011 | -0.069*** | -0.071*** | -0.096*** | -0.017*** | -0.020*** | -0.029*** |
| | (0.012) | (0.020) | (0.020) | (0.004) | (0.006) | (0.006) |
| Observations | 30,575 | 30,575 | 30,555 | 30,575 | 30,575 | 30,575 |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Plant-Level Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Sector FE | No | No | Yes | No | No | Yes |
| Mean Dep Var (pre 2007) | 0.193 | 0.193 | 0.194 | 0.208 | 0.208 | 0.208 |

Note: This table presents estimates of the average marginal effects in the Probit model, and of the average marginal effects on the truncated expected value of the share of TAW in the Tobit models. Size is a dummy variable that identifies plants with total employment in the top quintile, as of 2003. Volatility is defined as the standard deviation of the five lags of the fitted value of the log difference in value added. To predict value-added, we use the log difference of input prices multiplied by input shares, export shares, and the imported input share multiplied by the log difference of nominal exchange rate. All models include year fixed effects and controls for input prices interacted with input shares and nominal exchange rate multiplied by export share and imported input share. We also control by the fitted value of the log difference in value added and two additional lags. Year 2001 is ommited. Robust SE are clustered at the plant level, *p<.05; **p<.01; ***p<.001.

Table 3: Use of TAW: Heckit

| | I(TAW>0)) | | | %TAW \| TAW>0 | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Volatility (Proxy) | 0.575*** | 0.231 | 0.231 | 0.366*** | 0.177 | 0.196 |
| | (0.116) | (0.153) | (0.153) | (0.114) | (0.146) | (0.165) |
| Size (Above p75) | 0.069*** | 0.063*** | 0.063*** | -0.006 | -0.009* | -0.010* |
| | (0.005) | (0.006) | (0.006) | (0.004) | (0.005) | (0.005) |
| Volatility × DRef | | 0.836*** | 0.835*** | | 0.517** | 0.649*** |
| | | (0.237) | (0.237) | | (0.241) | (0.251) |
| Size × DRef | | 0.014 | 0.014 | | 0.008 | 0.009 |
| | | (0.009) | (0.009) | | (0.008) | (0.008) |
| Year 2003 | 0.008 | 0.007 | 0.007 | 0.013 | 0.013 | 0.017** |
| | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) |
| Year 2004 | 0.006 | 0.008 | 0.008 | 0.024*** | 0.025*** | 0.020** |
| | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) |
| Year 2005 | 0.018** | 0.013 | 0.013 | 0.048*** | 0.046*** | 0.038*** |
| | (0.009) | (0.009) | (0.009) | (0.008) | (0.009) | (0.009) |
| Year 2006 | 0.004 | 0.001 | 0.001 | 0.034*** | 0.032*** | 0.026*** |
| | (0.009) | (0.010) | (0.010) | (0.009) | (0.009) | (0.009) |
| Year 2007 | -0.002 | -0.045*** | -0.045*** | 0.040*** | 0.014 | 0.013 |
| | (0.009) | (0.015) | (0.015) | (0.010) | (0.015) | (0.015) |
| Year 2008 | -0.019* | -0.070*** | -0.070*** | 0.021* | -0.012 | -0.028 |
| | (0.011) | (0.018) | (0.018) | (0.011) | (0.019) | (0.019) |
| Year 2009 | -0.028** | -0.085*** | -0.085*** | 0.040*** | 0.004 | -0.003 |
| | (0.012) | (0.020) | (0.020) | (0.012) | (0.020) | (0.020) |
| Year 2010 | -0.035** | -0.095*** | -0.095*** | 0.019 | -0.021 | -0.041* |
| | (0.014) | (0.022) | (0.022) | (0.014) | (0.023) | (0.023) |
| Year 2011 | -0.033*** | -0.100*** | -0.100*** | 0.015 | -0.028 | -0.066*** |
| | (0.012) | (0.022) | (0.022) | (0.013) | (0.023) | (0.025) |
| I(TAW>0) in 2001 | 0.294*** | 0.295*** | 0.295*** | | | |
| | (0.003) | (0.003) | (0.003) | | | |
| Observations | 27,097 | 27,097 | 27,097 | 27,097 | 27,097 | 27,097 |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Plant-Level Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Sector FE | No | No | Yes | No | No | Yes |
| Mean Dep Var (pre 2007) | 0.194 | 0.194 | 0.194 | 0.202 | 0.202 | 0.202 |
| Rho | | | | -0.0948 | -0.0973 | -0.0889 |

Note: This table presents estimates of the marginal effects from a Heckman selection model. Size is a dummy variable that identifies plants with total employment in the top quintile, as of 2003. Volatility is defined as the standard deviation of the five lags of the fitted value of the log difference in value added. To predict value-added, we use the log difference of input prices multiplied by input shares, export shares, and the imported input share multiplied by the log difference of nominal exchange rate. All models include year fixed effects and controls for input prices interacted with input shares and nominal exchange rate multiplied by export share and imported input share. We also control by the fitted value of the log difference in value added and two additional lags. Our exclusion variable is a dummy standing for the use of TAW in 2001. Thus, Year 2002 is ommited. Robust SE are clustered at the plant level, *p<.05; **p<.01; ***p<.001.

Table 4: Difference in Differences

| | Ln Emp | | Ln Non TAW | | Ln Output | | ArcsinH Profit | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| I(TAW 2006>0) × DRef | -0.086*** | -0.149*** | 0.092*** | 0.139*** | -0.057*** | -0.137*** | -0.889** | -2.093*** |
| | (0.019) | (0.041) | (0.023) | (0.049) | (0.019) | (0.043) | (0.382) | (0.644) |
| Mills Ratio × DRef | | 0.044* | | -0.033 | | 0.056** | | 0.838** |
| | | (0.025) | | (0.031) | | (0.027) | | (0.368) |
| Observations | 43,819 | 43,819 | 43,819 | 43,819 | 43,804 | 43,804 | 43,819 | 43,819 |
| R-squared | 0.939 | 0.939 | 0.933 | 0.933 | 0.966 | 0.966 | 0.466 | 0.466 |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Plant FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Mean Dep Var (level) | 82.93 | 82.93 | 74.30 | 74.30 | 6.700 | 6.700 | 0.560 | 0.560 |

Robust SE clustered at plant level

*p<.05; **p<.01; ***p<.001

Note: This table presents estimates obtained from our main difference in differences strategy, presented in Equation [4] and Equation [5]. All models include controls for input prices interacted with input shares and nominal exchange rate multiplied by export share and imported input share. We also include a time trend specific to plants using TAW before the reform, as well as year and plant fixed effects.

Table 5: Difference in Differences: Intensity of TAW use

| | Ln Emp | | Ln Non TAW | | Ln Output | | ArcsinH Profit | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| (%TAW $\in$ Q1 \| TAW>0) $\times$ DRef | -0.050** | -0.114*** | -0.021 | 0.021 | -0.065*** | -0.146*** | -0.711 | -1.893*** |
| | (0.022) | (0.042) | (0.023) | (0.049) | (0.023) | (0.044) | (0.519) | (0.727) |
| (%TAW $\in$ Q2 \| TAW>0) $\times$ DRef | -0.129*** | -0.194*** | 0.222*** | 0.264*** | -0.047* | -0.130*** | -1.086** | -2.278*** |
| | (0.028) | (0.046) | (0.040) | (0.057) | (0.027) | (0.048) | (0.511) | (0.735) |
| Mills Ratio $\times$ DRef | | 0.045* | | -0.029 | | 0.057** | | 0.826** |
| | | (0.025) | | (0.030) | | (0.027) | | (0.368) |
| Observations | 43,819 | 43,819 | 43,819 | 43,819 | 43,804 | 43,804 | 43,819 | 43,819 |
| R-squared | 0.939 | 0.939 | 0.934 | 0.934 | 0.966 | 0.966 | 0.466 | 0.466 |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Plant FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Mean Dep Var (level) | 82.9 | 82.9 | 74.3 | 74.3 | 6.7 | 6.7 | 0.6 | 0.6 |
| Ho: Equal Coef. (p-value) | 0.02 | 0.02 | 0.00 | 0.00 | 0.60 | 0.61 | 0.59 | 0.58 |
| Ho: Jointly Significant. (p-value) | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0 | 0.05 | 0.00 |

Robust SE clustered at plant level
*p<.05; **p<.01; ***p<.001

Note: This table presents estimates obtained from the specification presented in Equation [6]. All models include controls for input prices interacted with input shares and nominal exchange rate multiplied by export share and imported input share. We also include a time trend specific to plants using TAW before the reform, as well as year and plant fixed effects.

Table 6: Lagged Dependent Variable (IV) and Plant Specific Trend

| | Ln Emp | | Ln Non TAW | | Ln Output | | ArcsinH Profit | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| $\Delta$ (I(TAW 2006>0) $\times$ DRef) | -0.080*** | | 0.048*** | | -0.027* | | -0.127 | |
| | (0.017) | | (0.019) | | (0.015) | | (0.419) | |
| $\Delta$ (I(TAW 2006>0) $\times$ DRef) | | -0.060*** | | 0.065*** | | -0.016 | | -0.163 |
| | | (0.017) | | (0.020) | | (0.015) | | (0.423) |
| Observations | 36,972 | 41,313 | 29,478 | 41,292 | 36,941 | 41,294 | 36,972 | 41,313 |
| R-squared | -0.057 | 0.179 | -0.083 | 0.193 | -0.019 | 0.196 | -0.125 | 0.083 |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Plant FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Lagged Dep. Var | Yes | No | Yes | No | Yes | No | Yes | No |
| Plant Specific Trend | No | Yes | No | Yes | No | Yes | No | Yes |
| Mean Dep Var (level) | 87.4 | 85.3 | 79.3 | 76.4 | 7.2 | 6.9 | 0.5 | 0.6 |
| First Stage F-stat | 261.7 | | 112.5 | | 353.6 | | 4483.0 | |

Robust SE clustered at plant level
*p<.05; **p<.01; ***p<.001

Note: This table presents estimates obtained from a model in first differences that includes lagged dependent variable and a model with a plant-specific time trend. Even columns correspond to the model with lagged dependent variable presented in Equation [7] and odd columns show the results obtained from the model with plant specific trend presented in Equation [8]. We instrument the lagged difference in the outcome variable with its twice lagged difference. All models include differentiated controls for input prices interacted with input shares and nominal exchange rate multiplied by export share and imported input share. We also include year fixed effects.

# Appendix

## Appendix A: Data

We use the Annual National Industrial Survey (ENIA) carried out by the National Institute of Statistics of Chile (INE) for the years 1995 through 2011. This survey covers the universe of Chilean manufacturing plants with 10 or more workers, although there are signs that its coverage has been falling in the last years. The dataset also includes plants with fewer than 10 employees if these plants had 10 or more employees in previous years. A plant is not necessarily a firm, since they may have several plants; however, a significant percentage of plants are single-plant firms. The INE updates the survey annually by incorporating new plants that started operating during the year and excluding those plants that stopped operating for any reason, generating an unbalanced panel that follows plants over time.

For each plant, the ENIA collects data on production (value of output), value added, total employment, and wages (for regular and agency workers), exports, electricity, fossil fuel (oil and gas), direct import of inputs, profit, and other plant characteristics. The ENIA classifies plants according to the 3-digit ISIC (Rev. 3) code, and the Institute of Statistics (INE) produces 3-digit level price deflators and a manufacturing real wage index. The latter index accounts for composition effects and therefore is the best proxy for the log change of the cost of labor. For our analysis, we deflate all nominal variables by the annual average Consumer Price Index (output, nominal exchange rate, etc.). Although the INE collects quarterly data for employment, we decided to use annual data because other variables have an annual frequency.

The ENIA uses the following classification for labor at the plant level:

| A. Employees with a direct contract | B. Employees without a direct contract: |
|---|---|
| A1.-Owner and managers | B1.- Skilled and unskilled Blue Collar TAW |
| A2.-Skilled and Unskilled Blue Collar Workers | B2.- White collar TAW |
| A3.-White collar workers | B3- Sales outsourcing |

In our analysis, we define "total employment" as A + B, and we define temporary agency workers as B1 + B2. We do not consider sales outsourcing because we focus on temporary agency workers who are substitutes for regular workers. We also construct the following variables:

- Plant level export and import shares as the three years moving average of the ratio of nominal exports and over nominal production and direct import of inputs over nominal production, respectively.
- Plant level input shares for labor, electricity, fuel, and natural gas as the "whole period" average of the expenditure in each input divided by output.
- Plant profit share as the ratio between profit and output.

Table A1 below presents some descriptive statistics of the dataset we use.

Table A1: Descriptive Statistics

| **Plant-Year data: 2001-2011** | Observations | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Total Employment (log) | 53,846 | 3.48 | 1.20 | - | 8.66 |
| Regular Employment (log) | 53,846 | 3.42 | 1.18 | - | 8.18 |
| Output (log) | 53,829 | 13.24 | 1.88 | 6.15 | 22.20 |
| Value Added (log) | 51,760 | 12.11 | 1.89 | 2.28 | 21.93 |
| Share of TAW | 53,846 | 0.04 | 0.13 | - | 0.99 |
| Total Employment (log change) | 43,882 | -0.00 | 0.25 | -1.50 | 1.44 |
| Profit / Output * | 53,304 | 0.04 | 0.14 | -1.54 | 0.76 |
| Inverse hyperbolic sine of Profit | 53,304 | 6.43 | 8.28 | -18.13 | 22.47 |
| Value Added (log change) | 43,882 | 0.00 | 0.59 | -3.33 | 3.02 |
| SD Value Added (log change) | 40,250 | 0.49 | 0.38 | 0.00 | 3.74 |
| SD Predicted Value Added (log change) | 31,670 | 0.06 | 0.03 | 0.00 | 0.25 |
| **Plant-Year data: 1995-2011** | | | | | |
| Export Share | 71,158 | 0.07 | 0.21 | - | 1 |
| Import Share | 74,045 | 0.08 | 0.18 | - | 1 |
| **Plant level data** | | | | | |
| Labor Share | 15,766 | 0.24 | 0.15 | - | 1.20 |
| Fuel Share | 15,801 | 0.02 | 0.02 | - | 0.24 |
| Electricity Share | 15,774 | 0.02 | 0.02 | - | 0.22 |
| **Year level data: 1995-2011** | | | | | |
| Manuf.Wage (log) | 17 | 4.30 | 0.17 | 4.07 | 4.57 |
| Electricity Price (log) | 17 | 3.79 | 0.34 | 3.27 | 4.31 |
| Oil Price (log) | 17 | 9.74 | 0.56 | 8.70 | 10.50 |
| Real Exch.Rate (log) | 17 | 6.14 | 0.18 | 5.78 | 6.43 |
| **Sector-Year data: 1995-2011** | | | | | |
| Deflactor (log) | 296 | 4.61 | 0.24 | 3.95 | 5.68 |

Note: We exclude the 1% extreme values of profit/output.
Source: Authors' construction using ENIA and INE wage and price indexes.

Table A2a and A2b present the share of temporary agency workers, the share of plants with at least one TAW, and the share of agency workers conditional to have at least one of them, for plants with different size and for plants that faced a different level of volatility, respectively. In Table A2a, we split plant-years observation into 20 groups by the level of plant employment. In Table A2b, we split plant-years into 20 groups by the five years moving standard deviation of log change of value added.

Table A2a: TAW by Plant´s Size

| Plant Size Quantiles | Mean Emp | Share of TAW | Share of plants with TAW | Share TAW \| TAW $\geq$0 |
|---|---|---|---|---|
| 1 | 5.1 | 0.009 | 0.026 | 0.356 |
| 2 | 7.5 | 0.016 | 0.051 | 0.319 |
| 3 | 9.5 | 0.016 | 0.056 | 0.285 |
| 4 | 11.5 | 0.014 | 0.058 | 0.241 |
| 5 | 13.5 | 0.022 | 0.088 | 0.249 |
| 6 | 15.5 | 0.020 | 0.088 | 0.223 |
| 7 | 17.5 | 0.027 | 0.106 | 0.256 |
| 8 | 19.5 | 0.028 | 0.108 | 0.256 |
| 9 | 21.9 | 0.025 | 0.104 | 0.238 |
| 10 | 24.9 | 0.033 | 0.135 | 0.242 |
| 11 | 28.9 | 0.032 | 0.135 | 0.233 |
| 12 | 33.9 | 0.041 | 0.180 | 0.229 |
| 13 | 39.9 | 0.040 | 0.187 | 0.212 |
| 14 | 48.2 | 0.047 | 0.226 | 0.209 |
| 15 | 59.7 | 0.057 | 0.263 | 0.217 |
| 16 | 75.7 | 0.067 | 0.298 | 0.226 |
| 17 | 101.4 | 0.066 | 0.311 | 0.214 |
| 18 | 147.3 | 0.068 | 0.322 | 0.213 |
| 19 | 243.4 | 0.084 | 0.388 | 0.217 |
| 20 | 701.3 | 0.138 | 0.455 | 0.302 |

Note: Plant size is defined as the total number of workers in a plant.
Source: Authors' construction using ENIA.

Table A2b: TAW by Plant´s Volatility

| Plant Volatility Quantiles | Mean Emp | Share of TAW | Share of plants with TAW | Share TAW \| TAW $\geq$ 0 |
|---|---|---|---|---|
| 1 | 48.7 | 0.022 | 0.108 | 0.207 |
| 2 | 68.5 | 0.025 | 0.148 | 0.168 |
| 3 | 74.4 | 0.028 | 0.157 | 0.182 |
| 4 | 73.5 | 0.028 | 0.148 | 0.190 |
| 5 | 78.0 | 0.028 | 0.160 | 0.177 |
| 6 | 72.3 | 0.028 | 0.142 | 0.199 |
| 7 | 79.0 | 0.026 | 0.150 | 0.171 |
| 8 | 87.3 | 0.033 | 0.166 | 0.196 |
| 9 | 87.4 | 0.037 | 0.182 | 0.201 |
| 10 | 81.8 | 0.037 | 0.188 | 0.197 |
| 11 | 81.5 | 0.043 | 0.173 | 0.246 |
| 12 | 92.8 | 0.043 | 0.186 | 0.230 |
| 13 | 94.5 | 0.048 | 0.200 | 0.242 |
| 14 | 96.3 | 0.048 | 0.222 | 0.217 |
| 15 | 98.9 | 0.049 | 0.215 | 0.230 |
| 16 | 103.7 | 0.059 | 0.224 | 0.262 |
| 17 | 101.4 | 0.055 | 0.208 | 0.263 |
| 18 | 97.9 | 0.058 | 0.207 | 0.282 |
| 19 | 107.3 | 0.059 | 0.208 | 0.285 |
| 20 | 103.2 | 0.068 | 0.221 | 0.310 |

Note: Plant volatility is defined as the standard deviation of the last 5 log change of value added.
Source: Authors' construction using ENIA.

## Appendix B: Plant's volatility and TAW use

Equation 9 presents the model used to compute the predicted log change in value added ($dl\hat{va}$):

$$\begin{aligned} dlva_{i(j)t} = \quad & \alpha_j + \gamma_t + a_1 ShL_{i(j)} \times dlw_{manuf,t} + a_2 ShE_{i(j)} dlPe_{eco,t} + a_3 ShO_{i(j)} dlPoil_{eco,t} \\ & + a_4 ShExp_{i(j)t} dlRER_t + a_4 ShImp_{i(j)t} dlRER_t + a_5 dlDef_{jt} + a_6 dlva_{i(j)t-1} + \mu_{i(j)t}, \end{aligned} \tag{9}$$

where $dlva_{i(j)t}$, $ShX_{i(j)}$ and $dlPX_{jt}$ stand respectively for the log change in value added at plant $i$, in sector $j$, at period $t$; the share of input $X \in$ {Labor, Electricity, Oil} in plant $i$ of sector $j$ (constant over time); and the log change in the price of input $X$ (at the manufacturing level for wages and at the economy level for electricity and oil prices). $a_4 ShExp_{i(j)t}$ and $ShImp_{i(j)t}$ stand for the export and input import shares at the plant level (% of nominal output) in the last three years, and $dlRER_t$ and $dlDef_{jt}$ represent the log change in the real exchange rate (nominal exchange rate divided by local inflation) and the log change in the real price index at the three ISIC rev3 levels (from the National Institute of Statistics).

In a small open economy like Chile, plants in tradeable sectors, like manufacturing, are price takers (the average tariff in Chile is lower than 1%, and it is zero in manufacturing). Based on this, we estimate equation 9 and the predicted values for the log change of value-added at the plant level for the period 1997-2011. Following the literature, we use the second lag of the log change in value-added as an instrument for the first lag in equation 9. Table B1 below shows our results. Our composite instrument for external shocks is highly significant, although it explains only 1 % of the variance of log change of value added in our sample.

To construct our plant-level volatility instrument, we use the predicted log change in value-added obtained before. For each year, we define volatility as the standard deviation of the last five lagged values. Specifically, we compute: $SD(dl\hat{v}a_{it}) = \left(\sum_{h=1}^{5}(dl\hat{v}a_{it-h} - \overline{dl\hat{v}a_{it}})^2/5\right)^{1/2}$, where $dl\hat{v}a_{it}$ is the predicted value of the log change of value added.

Table B1: Log Change in Value-Added

| | VA (log change) | |
|---|---|---|
| | (1) | (2) |
| Labor Share × Wage (log change) | -2.548*** | -2.428*** |
| | (0.802) | (0.822) |
| Energy Sahre × Elect.Price (log change) | -5.171*** | -5.138*** |
| | (1.584) | (1.588) |
| Oil Share × Oil Price (log change) | -1.593*** | -1.671*** |
| | (0.573) | (0.578) |
| Export Share | 0.024 | 0.021 |
| | (0.021) | (0.021) |
| Export Share × RER (log change) | 0.181 | 0.191 |
| | (0.246) | (0.246) |
| Import Share | -0.032* | -0.027 |
| | (0.019) | (0.020) |
| Import Share × RER (log change) | -0.079 | -0.061 |
| | (0.235) | (0.234) |
| Sector Price (log change) | 0.228*** | 0.229*** |
| | (0.044) | (0.046) |
| IV Lag VA (log change) | 0.092*** | 0.086*** |
| | (0.021) | (0.021) |
| Observations | 44,002 | 44,002 |
| R-squared | 0.011 | 0.012 |
| Year FE | Yes | Yes |
| Sector FE | No | Yes |

Robust SE
*p<.05; **p<.01; ***p<.001

Note: This table presents OLS estimates of equation 9, using data between 1997-2011. Labor share, energy share, and oil share stand for wage compensation, energy expenditure (electricity), and oil expenditure, all over total nominal output. Export share and Import share stand for nominal exports and nominal imported inputs over nominal output. RER stands for the real exchange rate. Sector Price is the real price index at the three ISIC rev3 levels (from the National Institute of Statistics). We instrument Lag VA (log) using its first lag.

Table B2 explores how the presence of TAW might affect value added and output after an external shock. In column 1, we regress the log change of value added on the predicted log change value added from table B1 (our proxy for external shocks). The sample period is restricted to the period for which we have data on TAW (2001-2011). Not surprising, the coefficient for our proxy for external shock is close to one (0.94) and highly significant, although the R-squared is small (0.012).

In columns 2 and 3, we study the role of TAW as a shock amplifier. In column 2, the main term for our proxy for external shock is 0.86, and the interaction term of external shock and the dummy variable for the presence of TAW the previous year is positive but not at statistically significant standard levels. Column 3 splits plants with TAW above and below the median share of TAW. The interaction term for plants with TAW below the median has the expected positive sign, but it is not significant at standard levels. However, for plants with a TAW share above the median, the coefficient is larger (0.63) and significant with 99 % of confidence. These results show signs of reverse causality between TAW and value-added volatility, i.e. TAW-user plants react more to external shock than plants without TAW.

Table B2: Exogenous Volatility and VA volatility

| | VA (log change) | | | Std. Dev. VA (log change) | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Predicted VA (log change) | 0.937*** | 0.856*** | 0.811*** | | |
| | (0.103) | (0.215) | (0.216) | | |
| Predicted VA (log change) × DTAW(≤median)$_{t-1}$ | | | 0.127 | | |
| | | | (0.217) | | |
| Predicted VA (log change) × DTAW (≥median)$_{t-1}$ | | | 0.629*** | | |
| | | | (0.234) | | |
| DTAW (≤median)$_{t-1}$ | | | -0.001 | | |
| | | | (0.017) | | |
| DTAW (≥median)$_{t-1}$ | | | 0.007 | | |
| | | | (0.015) | | |
| Predicted VA (log change) × DTAW$_{t-1}$ | | 0.138 | | | |
| | | (0.143) | | | |
| DTAW$_{t-1}$ | | 0.024** | | | 0.014*** |
| | | (0.011) | | | (0.005) |
| SD (Predicted dlva) | | | | 1.842*** | 1.847*** |
| | | | | (0.209) | (0.213) |
| Observations | 33,078 | 33,078 | 33,078 | 33,606 | 32,956 |
| R-squared | 0.010 | 0.010 | 0.011 | 0.073 | 0.074 |
| Year and Sector FE | No | Yes | Yes | Yes | Yes |

Robust SE, clustered at the sector-year level
*p<.05; **p<.01; ***p<.001

Note: : "Std. Dev. VA (log change)" stands for the standard deviation of the last five values of VA (log change). "Predicted VA (log change)" is the predicted value of VA (log change) from the Table B1. "DTAW(≤median)$_{t-1}$" ("DTAW(≥median)$_{t-1}$") stands for a dummy variable that equals one if the share of TAW is below (above) the median value in $t-1$. "SD(Predicted dlva)" stands for the standard deviation of the predicted last five lagged values of VA (log change). This table presents OLS estimates using data between 2001 and 2011.

Finally, columns 4 and 5 show the identification power of our instrument for exogenous volatility. We perform a simple OLS estimation $SD(dlva_{it})$ on $SD(dl\hat{v}a_{it})$ and time and sector dummies. As expected, in column 4, the coefficient for $SD(dl\hat{v}a_{it})$ is positive, larger than one (1.84), and significant at 1%. Contrary to the standard deviation of the log change of value-added, the standard deviation of our external shock proxy does not include the amplification effect triggered by the employment reaction to external shocks. In column 5, we include a dummy variable equal to one if the plants used TAW the previous year. The dummy coefficient is positive and significant at 1%, reinforcing our previous results.