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Articles

Dynamic interaction between permanent and temporary employment across manufacturing labor markets in the Mexican states: A structural panel VAR approach

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Abstract:

México's implementation of several labor market reforms aimed to stimulate the flexibilization of labor relationships have brought long-standing concerns among scholars and governmental authorities about a displacement process of permanent by temporary jobs. In this regard, this manuscript aims to respond whether the dynamic interaction between permanent and temporary employment across Mexican states describe a substitution or complementary relationship. By means of implementing a structural panel vector autoregressive model, our estimation results demonstrate that a combination of both types of interaction, substitutive and complementary ones, prevail across manufacturing labor markets at state level. Moreover, a marked heterogeneity among estimated dynamic responses suggests that incentivizing permanent employment would induce stronger substitution effects on its temporary counterpart than, for example, substitution of permanent job positions arising when incentivizing temporary employment.

Keywords: Permanent employment; temporary employment; regional labor markets; México; structural panel VAR.
JEL classification: C23; E24; J0; L60; R10.

Interacción dinámica entre el empleo permanente y temporal en los mercados manufactureros regionales de los estados mexicanos: un enfoque de VAR estructural en panel

Resumen:

La implementación de varias reformas laborales en México, cuyo propósito fue estimular la flexibilización de las relaciones laborales, ha atraído un interés duradero de académicos y autoridades gubernamentales acerca del desplazamiento de empleos permanentes por empleos temporales. En tal sentido, esta investigación tiene el propósito de responder si la interacción dinámica entre los empleos permanentes y temporales en los estados mexicanos describen una relación sustitutiva o complementaria. Mediante la implementación de un modelo de vectores autoregresivos estructurales en panel, nuestras estimaciones demuestran que ambos tipos de interacción prevalecen en los mercados regionales de trabajo manufacturero con marcadas asimetrías que sugieren las políticas para fomentar el empleo permanente tendrían una mayor efecto sustitutivo que aquéllas diseñadas para promover el empleo temporal.

Palabras clave: Empleo permanente; empleo temporal; mercado laboral regional; México; Panel VAR estructural.
Clasificación JEL: C23; E24; J0; L60; R10.

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1. Introduction

During the last decades, both developed and developing economies have adopted wide labor market reforms aiming at providing the economic incentives and institutional conditions for achieving less rigidity in their functioning. In this regard, labor market flexibility has been generally envisioned as a means for firms' adaptation to market fluctuations, both expected and unexpected, to cut labor costs and rise productivity (Van, 2003) as well as providing unemployment alleviation (OECD, 1994). As a result, new types of flexible labor contracts have emerged, importantly, temporary employment which has exhibited a generalized increase along with significant variations across the countries and regions that have gradually embraced flexible-oriented labor market policies.

The evidence in this regard indicates, for example, that the share of temporary workers in total employment has increased from 9 to 14 percent in the European Union over the last three decades with Spain and Poland showing rates as high as 25 percent in 2014. Similarly, these figures have also increased moderately in most Latin American countries with both, Ecuador and Perú, achieving proportions slightly above 50 and 60 percent in 2013, respectively (International Labour Organization, 2016).

In the case of México, a deep process of reforms aiming at opening the economy and deregulating markets as well as reprivatizing public firms has been in curse since the mid-eighties (Cárdenas, 1996; Moreno & Ros, 2009). Even if the labor reform was approved until late 2012, different forms of more flexible labor contracts were in place as a means for improving the competitiveness and growth of the economy (Secretaría de Gobernación, 2013). Indeed, the corresponding government administrations not only allowed these new contracts but encouraged them to also improve the attractiveness of the economy (De la Garza, 2010; Mendoza, 2017). Consequently, according to official information published by the Mexican Institute of Social Security (IMSS, for its acronym in Spanish), the share of permanent employment in the total one has decreased from 95 percent to 86 percent in a fifteen-year period thus reflecting the increasing importance of more flexible employment contracts.[2]

Although the increasing labor market flexibilization encompassing global trends may be seen as a successful component of the market reforms package in México, as it may have contributed to boosting exports, foreign direct investment, employment and output, some concerns have recently emerged regarding its adverse effects on the population's standards of living resulting from the rise of temporary and informal jobs (González, 2012; Quintana & Garza, 2017). Moreover, a labor market issue that has received little attention from scholars is the identification of patterns regarding the dynamic interaction between the permanent and temporary components of employment resulting from the implemented labor market reforms within the Mexican states.

Recent data show that shares of temporary jobs were lower than 10 percent in most Mexican states in 2003, with only six of them displaying higher shares. However, because of high growth rates, this situation reversed up to the point where most of them showed two-digit shares of temporary employment, with figures over 20 percent in some cases over the subsequent years; state permanent employment, on the contrary, has experienced lower or even negative average growth rates over the same period. These patterns reflect significant heterogeneity in the adoption of labor policy reforms across the Mexican states, thus making difficult to distinguish the predominant strategic interaction between these two types of employment, that is, whether states' economic agents have pursued a substitution or a complementation process between permanent and temporary jobs.

In this context, the aim of this paper is to identify the type of interaction prevailing between temporary and permanent employment across the Mexican states over the period 2003-2022. Particularly, we intend to respond the following questions: does the dynamic interaction between permanent and temporary employment describe a substitution or a complementary relationship? And, given the relative stickiness of each type of employment,[3] is this interaction symmetric or asymmetric? To answer these

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[2] See its website at www.imss.gob.mx.

[3] For example, permanent jobs may be less responsive to changes in temporary jobs due to the existence of long-lasting labor contract or costs of hiring and firing.

questions, we use a structural panel vector autoregressive model[4] as proposed by Pedroni (2013), which allows us to investigate the dynamic response of the labor market variables to structural shocks in a panel setting thus useful in accounting for the observed heterogeneous behavior in the labor markets of the Mexican states.[5] In particular, this methodology will be useful to investigate whether variations in a type of manufacturing employment would subsequently induce substitution or complementary effects on the other type for each state, conditional on the possibility of adjustments in additional variables, such as output.

The rest of this paper is organized as follows: after the introduction, we present a brief literature review on some important tendencies in the labor market and, mainly, the interaction between permanent and temporary employment at international level as well as some of the major recent changes in the Mexican labor market. Afterwards we present data about the dynamics of permanent and temporary employment in Mexico and its states. Next, we present the main features of the econometric methodology, followed by the exposition and discussion of the most important findings; finally, the conclusions are stated.

2. Literature review

The dynamics of regional labor markets has received significant attention in the specialized literature.[6] One research area that has received some attention recently is the identification of significant spatial dependence in the emergence of "low" and "high" unemployment (employment) clusters in the European Union (Overman & Puga, 2002), Italy (Cracolici et al., 2007; Patacchini & Zenou, 2007)), the United Kingdom (Patacchini & Zenou, 2007) and Spain (Cuéllar-Martín et al., 2019), which is explained by factors such as migration, employment demand, human capital availability, neighboring effects and productive structure among others. In turn, another set of studies have highlighted regional differences in Okun's Law, which states a negative relationship between the unemployment rate and the growth rate of output, in Spain (Bande & Martín-Román, 2018; Porras-Arena & Martín-Román, 2019), the United States (Guisinger et al., 2018) and Europe (Maza, 2022), for example. By using different methodologies, these studies report short-run and long-run negative relationships explained by gender and age, productivity and productive structure as well as the magnitude of self-employment and part-time employment and the severity of long-term unemployment among others. It is important to mention that not all of these studies give account of spatial spillovers.

Notwithstanding, one area that has received relatively little attention is the analysis of the dynamics and interaction of permanent and temporary employment despite the last decades have witnessed a significant increase of temporary employment resulting from the successive deregulation of the labor market in several countries with the aim of increasing overall employment and improving competitiveness of firms. In fact, mot existing papers have studied this process at a national level. Particularly, it has been argued that in a more competitive and globalized environment, temporary labor contracts have been used as a mechanism for firms to gain flexibility to face shocks and cut down costs (Vidal & Tigges, 2009; Cooke & Zeytinoglu, 2004). In addition, temporary jobs are associated to definite and short periods of time, which allows firms to respond faster to anticipated and unanticipated exogenous or policy shocks (Jahn & Bentzen, 2012). Furthermore, firms might favor temporary contracts to seek and screen qualified workers for permanent posts, which helps them to reduce hiring and recruitment costs, as well as to fulfill specific tasks of a temporary nature (Hirsch & Mueller, 2012; Bryson, 2013).

Nonetheless, although temporary employment can contribute to a better performance of firms, it may also have several disadvantages for workers. Specifically, greater flexibility of firm is based on short-

[4] This model has been mainly used in macroeconomics and finance to deal with the dynamics of phenomena involving heterogeneous units (Canova & Ciccarelli, 2013).

[5] This model allows us to estimate the dynamic response of each variable to shocks to the others through the impulse response functions within each state. Hence, the model does not consider spatial interactions, a feature that can be addressed in other frameworks, such as spatial panel data models.

[6] See Betcherman (2012), Moretti (2011) and Eichhorst et al. (2017) for surveys on the main transformations and results in different labor markets.

time contracts for workers, which may generate more job volatility and greater employment risk (Antoni & Jahn, 2009), while lowering costs has meant firms to pay lower wages and less additional benefits (Antoni & Jahn, 2009; Andersson & Wadensjö, 2011)[7] as well as to invest less in human capital (Bryson, 2013). In addition, it seems that temporary jobs are rarely steppingstones into permanent jobs (Kvasnicka, 2009; Autor & Houseman, 2010). Furthermore, the international evidence shows that even if labor market reforms have contributed to increase total employment, firms may be replacing permanent jobs by temporary ones as a systematic strategy to gain competitiveness (Cooke & Zeytinoglu, 2004; Vidal & Tigges, 2009; Jahn & Weber, 2016), which has worried both scholars and policy makers.

In the case of México, the labor market has also experienced deep transformations over the last decades after this country embraced a development model based on an open, market-oriented economy in the early eighties. In order to overcome the long-run restrictions to grow, México got involved in a wave of reforms to liberalize international trade and foreign investment and reprivatize public enterprises, among others, in order to boost productivity and base economic growth on the external sector by increasing manufacturing exports and attracting more foreign direct investment (Aspe, 1989; Moreno & Ros, 2009; Autor/a, 2014).

In this context, manufacturing firms restructured their productive processes by introducing new technologies and reorganizing their administrative models in order to gain greater flexibility within plants.[8] These processes were facilitated by the incentives provided by the government and the availability of infrastructure and productive factors, especially different types of qualified workers that could be hired by low wages (Chong-Sup, 2002; Amoroso et al., 2011). Also, firms increasingly relied on temporary workers, who were hired for specific short-time periods or activities that usually received lower wages and less benefits than permanent workers. Furthermore, outsourcing, commonly grounded on temporary jobs as well, has become an important source of labor supply to develop non-qualified activities at low costs (García, 2010; De la Garza, 2010; Mendoza, 2017).

Overall, these strategies have generated a significant increase of temporary employment, but its dynamics or the contrast of its characteristics with those of permanent employment have received little attention in the literature. In particular, several papers have analyzed the dynamics and determinants of national aggregate and sectoral employment at the national level (e.g. López, 1999; Mejía, Reyes & Rendón, 2017; Tavares & Varela, 2019), while some others have studied the experience of the Mexican states or cities trying to identify its determinants by estimating panel data models (Escobar, 2011; Carbajal & De Jesús, 2017) or spatial panel data models (Brito & Mejía, 2020; De Jesús, Andrés & Carbajal, 2020). In general, these studies identify important determinants of employment (mainly output, productive structure and spatial spillovers, with a minor role of wages and productivity) but they do not analyze the properties and determinants of temporary and permanent employment.

As far as we know, a few papers indirectly investigate some differences between temporary and permanent employment. Loría, Ramírez & Salas (2015), for example, find that labor flexibility (measured as the ratio of temporary employment to total employment) increases the unemployment rate within the Okun's Law framework, which contradicts some of the evidence reported for developed countries. In a similar line, Mendoza's (2017) results suggest that temporary employment and real wages are positively correlated in the long run to the unemployment rate in the Mexican states, which is consistent with the findings of Loría, Ramírez & Salas (2015). In turn, Autor/a (2020) look for differentiated effects of output and real wages on temporary and permanent employment across the Mexican states. By estimating spatial panel data models, they find negative direct effects of wages on temporary employment, but the opposite in the case of permanent employment. Also, they report total positive effects of output on both types of employment.

[7] Temporary employment allows firms to reduce labor costs directly by avoiding payment of higher wages bargained in sectoral collective agreements, dismissal costs and legal expenses in case of a trial, and other benefits (OECD, 2004; Houseman et al., 2003; Jahn, 2010).

[8] The labor relation arrangements were deeply modified to be based on flexible work rules and job rotation, broadly defined job classifications, "quality circles", work teams, and other measures designed to defuse labor-employer tensions and further motivate workers. See Middlebrook (1991)

It is important to highlight that in most papers analyzing the determinants of employment in México, output and real wages are usually assumed to be exogenous, sometimes without any justification. In a strict sense, the decisions of families and firms determine the full-employment level and, afterwards, the output one. Under conventional assumptions, real wages, employment, and output are simultaneously determined. However, in the Keynesian perspective, employment is determined by the effective demand, usually measured by the aggregate output, and real wages, which may be sticky and greater than the level that empties the labor market.[9] In this framework, output and wages may be seen as exogenous.

Overall, this literature review identifies some important stylized facts of the Mexican employment both at aggregate and sectoral levels as well as at a regional dimension. Nonetheless, it also shows that the analysis of the dynamics and determinants of temporary employment versus permanent employment is rather scarce. In this context, one open question is whether permanent jobs are being replaced by temporary ones in the case of the Mexican states, an issue addressed in the rest of this paper.

3. Spatial distribution of permanent and temporary manufacturing employment in México

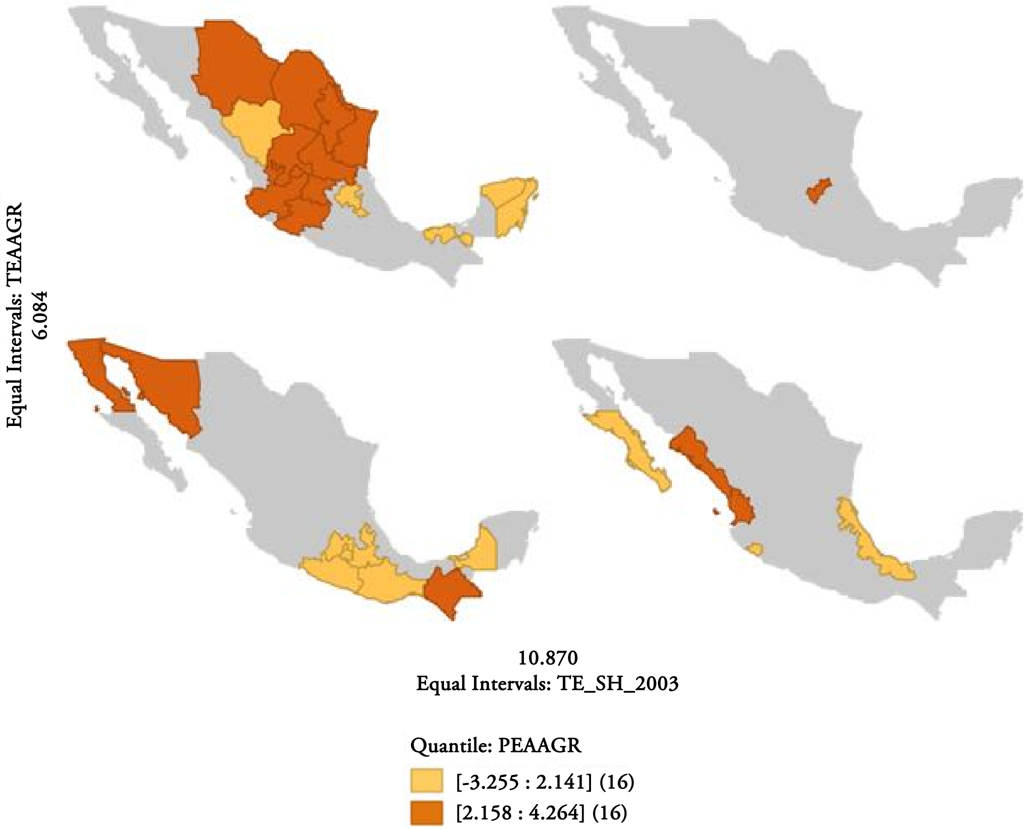
Over the last decades manufacturing employment has grown faster in northern and central-western states of Mexico (states in dark brown in maps of Figure 1) mainly because they modernized their productive activities to take advantage of a new development model and gained locational advantages after the North American Free Trade Agreement came into force in 1994 (Mejía and Torres, 2019). However, although total permanent employment has remained as the predominant form of labor contractual relationships within the manufacturing sector in México, the observed decrease in its ratio with respect to its temporary counterpart, from 18.7 to only 7.6 between 2003 and 2022, suggests that a substitutive process between both types of employment might be underway, perhaps, as a means for firms to enhance competitiveness and rise employment (García, 2010; De la Garza, 2010; Mendoza, 2017).

Furthermore, a look at the dynamics of both temporary and permanent employment across the Mexican states suggests that the transition towards more flexible labor markets has been rather distant from being uniform, as some states have accompanied this process with the preservation or even the encouragement of permanent employment contracts. In particular, the maps in Figure 1 show the spatial distribution of the annual average growth rate of permanent employment (PEAAGR), conditional on the growth rate (TEAAGR) and the share of temporary employment (TE_SH_2003), measured respectively on the vertical and horizontal axis. In this respect, most of the states in the upper-left map showing lower shares of temporary employment and high TEAAGR also had high PEAAGR, such as Chihuahua, Coahuila, Nuevo Leon, Tamaulipas, San Luis Potosi, Zacatecas, Guanajuato, Michoacan and Jalisco (dark brown). Accordingly, in the upper-right map, a similar pattern emerges in Queretaro (dark brown) where TE_SH_2003 is also high. In turn, the lower-left map suggests that permanent jobs are rapidly growing (with a low share of temporary employment) in a few states (Baja California, Sonora and Chiapas), while the lower-right map indicates that something similar is going on in Sinaloa, but with a high share of temporary jobs (in dark brown).

This process has caused a recomposition of employment within the Mexican states: while in 2003 the share of temporary employment in total employment were predominantly lower than 7.5 percent, over the subsequent two decades all states experienced an increase in those shares resulting from the introduction of firms' strategies to contract workers under more flexible forms which delivered out two-digit growth rates in a catching up process to build more flexible labor markets. Hence, these data show that permanent and temporary employment have grown at different paces reflecting processes of substitution or complementation strategies across the Mexican states.

[9] See Heijdra (2017) or Romer (2019) for standard presentations of the Neoclassical and Keynesian models. Mejía & Torres (2020) and Brito & Mejía (2020) adopt a New Keynesian Economics approach to specify their empirical models.

Figure 1.
Spatial distribution of permanent employment conditional on the growth rates and the share of temporary employment across the states of México



TEAAGR and PEAAGR stand for the annual average growth rate of temporary and permanent employment between 2003 and 2022, respectively. TE_SH_2003 is the share of temporary employment in total employment in 2003.
Source: own elaboration with information from IMSS.

4. Methodological aspects

To investigate whether the dynamic interaction between permanent and temporary employment features a substitution or a complementation relationship in the labor markets across the Mexican states, we propose to implement a three variable structural panel VAR system (permanent and temporary employment and output), according to the methodological approach introduced by Pedroni (2013). From a practical standpoint, this methodology is useful to our investigation as it allows us to explicitly account for the observed state heterogeneous behavior and provides us with an identification scheme based on the recursiveness assumption to properly uncover the dynamic response of each type of employment within each state to structural shocks.

The economic content of this identification scheme resides upon the endogenous economic and labor variables' time of response to structural shocks by assuming that some labor variables are contemporaneously predetermined and, therefore, the specification of the panel VAR system requires us to elaborate on the economic behavior of employers and employees across states regarding the timing of their responses to unexpected structural shocks affecting labor variables.

Specifically –concurring with the work of Galí (2013), who argues that, under a New Keynesian framework, an aggregate demand-driven positive output shock would induce a positive response in the aggregate employment level, and, along with the empirical findings of Brito and Mejía (2020) and Mejía and Torres (2020) for the case of México–, we propose that both permanent and temporary employment across states in México would positively respond to unexpected positive output shocks. We assume, moreover, that both types of employment would not contemporaneously react to unexpected positive output variations but with a time lag instead as this feature seems to describe the actual economic behavior of employers and employees more appropriately. Accordingly, this lagged response of aggregate employment to demand-driven positive output variations may be explained by the decision of firms to increase current employees' working hours and decrease underutilized capacity before intending to hire new employees, which helps to avoid substantial fixed costs associated to recruitment and training involved in hiring processes until firms are convinced that the demand for their products is stable or higher (Reserve Bank of Australia, 2014), (Bell, 1981).

Additionally, firms spend longer periods of time during the process of hiring permanent employees as compared to shorter periods in hiring temporary ones. The rationale behind this assumption resides in the fact that firms may spend several weeks or even months in recruiting and training employees for permanent posts and, therefore, it is plausible that unexpected shocks to temporary employment would likely induce lagged responses on permanent employment. Conversely, however, the significant shorter periods of time required in recruiting and training temporary employees, as per weeks or days, suggest that unexpected permanent employment shocks would contemporaneously affect temporary employment.

On this ground, the structural panel VAR system is described in its expanded form as in expression (1). It is composed by an M x 1 vector of endogenous variables in first differences with $M = 3$ and specified as $\Delta\boldsymbol{z'}_{it} = [\Delta pe_{it} \quad \Delta te_{it} \quad \Delta mp_{it}]'$, where Δ denotes the first difference operator and pe_{it} and te_{it} the permanent and temporary employment levels, respectively, while mp_{it} stands for the output level. In all cases, the indexes i and t represent, respectively, the Mexican states and time periods, while L denotes the lag operator. The exogenous error terms in the following M x 1 vector $\boldsymbol{\epsilon'}_{it} = \left[\epsilon_{it}^{pe} \quad \epsilon_{it}^{te} \quad \epsilon_{it}^{mp}\right]'$ are interpreted as structural innovations capturing unexpected shocks to their corresponding endogenous variables within the structural panel VAR system. The structural parameters, $b_{MM,i}$, within the left-hand matrix of expression (1), describe the endogeneity of each variable that will be subject to the identifying restrictions.

$$\begin{bmatrix} 1 & b_{12} & b_{13} \\ b_{21} & 1 & b_{23} \\ b_{31} & b_{32} & 1 \end{bmatrix} \begin{bmatrix} \Delta pe_{it} \\ \Delta te_{it} \\ \Delta mp_{it} \end{bmatrix} = \begin{bmatrix} \sum_{j=1}^{p} \gamma_{11j}{}^{i} L^{j} & \sum_{j=1}^{p} \gamma_{12j}{}^{i} L^{j} & \sum_{j=1}^{p} \gamma_{13j}{}^{i} L^{j} \\ \sum_{j=1}^{p} \gamma_{21j}{}^{i} L^{j} & \sum_{j=1}^{p} \gamma_{22j}{}^{i} L^{j} & \sum_{j=1}^{p} \gamma_{23j}{}^{i} L^{j} \\ \sum_{j=1}^{p} \gamma_{31j}{}^{i} L^{j} & \sum_{j=1}^{p} \gamma_{32j}{}^{i} L^{j} & \sum_{j=1}^{p} \gamma_{33j}{}^{i} L^{j} \end{bmatrix} \begin{bmatrix} \Delta pe_{it} \\ \Delta te_{it} \\ \Delta mp_{it} \end{bmatrix} + \begin{bmatrix} \epsilon_{it}^{pe} \\ \epsilon_{it}^{te} \\ \epsilon_{it}^{pm} \end{bmatrix} \quad (1)$$

The the compact matrix form of expression (1) is as follows:

$$\boldsymbol{B}_i \Delta\boldsymbol{z}_{it} = \sum_{j=1}^{p} \boldsymbol{\Gamma}_{ij} L^j \Delta\boldsymbol{z}_{it} + \boldsymbol{\epsilon}_{it} \quad (2)$$

Hence, the reduced panel VAR is obtained pre-multiplying expression (2) by $\boldsymbol{B}_i{}^{-1}$,

$$\Delta\boldsymbol{z}_{it} = \boldsymbol{B}_i{}^{-1} \sum_{j=1}^{p} \boldsymbol{\Gamma}_{ij} L^j \Delta\boldsymbol{z}_{it} + \boldsymbol{B}_i{}^{-1} \boldsymbol{\epsilon}_{it} \quad (3)$$

This last equation can also be expressed as $\Delta\boldsymbol{z}_{it} = \sum_{j=1}^{p} \mathbf{R}_{ij} L^j \Delta\boldsymbol{z}_{it} + \boldsymbol{u}_{it}$ or $\mathbf{R}_i(L)\Delta\boldsymbol{z}_{it} = \boldsymbol{u}_{it}$.[10] The reduced white noise error term $\boldsymbol{u}_{it}$ is a linear combination of the structural shocks as can be seen in the expression $\boldsymbol{u}_{it} = \boldsymbol{B}_i{}^{-1}\boldsymbol{\epsilon}_{it}$, with a covariance matrix given by $E[\boldsymbol{u}_{it}\boldsymbol{u}'_{it}] = \boldsymbol{B}_i{}^{-1} E[\boldsymbol{\epsilon}_{it}\boldsymbol{\epsilon}'_{it}] \boldsymbol{B}_i{}^{-1\prime} = \boldsymbol{\Omega}_{u,i}$.

In turn, the reduced moving average representation is found by multiplying the reduced panel VAR by $\mathbf{R}_i(L)^{-1}$, which leads to:

[10] Which implies that $\sum_{j=1}^{p} \mathbf{R}_{ij} L^j = \boldsymbol{B}_i{}^{-1} \sum_{j=1}^{p} \boldsymbol{\Gamma}_{ij} L^j$ and $\mathbf{R}_i(L) = \boldsymbol{I}\text{-}\sum_{j=1}^{p} \mathbf{R}_{ij} L^j$.

$$\Delta \boldsymbol{z}_{it} = \mathbf{F}_i(L)\boldsymbol{u}_{it} \tag{4}$$

From the last expression, the structural moving average representation can, thus, be obtained by substituting the reduced shock $\boldsymbol{u}_{it} = \boldsymbol{B}_i{}^{-1}\boldsymbol{\epsilon}_{it}$ into the expression (4):

$$\Delta \boldsymbol{z}_{it} = \mathbf{A}_i(L)\boldsymbol{\epsilon}_{it} \tag{5}$$

The relation $\mathbf{A}_i(L) = \mathbf{F}_i(L)\boldsymbol{B}_i{}^{-1}$ is of relevance for our investigation as it represents the impulse responses associated to the corresponding structural shock $\boldsymbol{\epsilon}_{it}$ that describes the complete dynamic interaction between the economic and labor variables.

5. Identification and estimation aspects

The identification and posterior estimation of the impulse responses of the variables in the model to structural shocks for each state are based on short-run timing identifying restrictions.[11] This approach offers several methodological advantages as some studies have concluded that it delivers robust estimations to either first differencing the data or imposing cointegrating relationships (Gospodinov, Herrera and Pesavento, 2013) and, additionally, it reliably recovers and identifies the dynamic impacts of economic shocks as the sample properties of the impulse responses are robust under alternative specifications (Christiano, Eichenbaum and Vigfusson, 2006).

In this respect, the short-run identifying restrictions are imposed on the contemporaneous matrix of the dynamic structural responses $\mathbf{A}_i(0)$ in a manner that resembles the economic behavior of employers and employees across states described in the previous section.[12] To be more specific, the implemented recursive short-run restrictions thus imply that both permanent and temporary employment would respond with a time lag to unexpected demand-driven changes in the output level and that permanent employment would do so in response to unexpected temporary employment shocks, which are respectively described in the first two rows within expression (6):

$$\mathbf{A}_i(0)=\begin{bmatrix} a_{11} & 0 & 0 \\ a_{21} & a_{22} & 0 \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \tag{6}$$

Regarding estimation issues, we provide estimates of idiosyncratic structural impulse responses because the exploratory analysis strongly suggests the observed heterogeneity in the labor dimensions across time and space may reflect state-specific decisions of employers and employees on how they took advantage of recent national labor policy reforms. The practical procedure to obtain the idiosyncratic structural impulse responses requires, first, estimating the three variable VAR system in its reduced form for each state i by using the first-differenced endogenous variables in both the vectors $\Delta \boldsymbol{z}_{it}$ and $\Delta \bar{\boldsymbol{z}}_t$, where the former comprises the raw data and the latter contains the components of the former that are common to all states, which has been labeled by Pedroni (2013) as time effects.[13] Then, we use the contemporaneous covariance matrix of the estimated reduced form residuals for both types of VARs, and jointly with the short run identifying restrictions in $\mathbf{A}_i(0)$, built the mapping relations $\bar{\boldsymbol{u}}_t = \bar{\mathbf{A}}(0)\bar{\boldsymbol{\epsilon}}_t$ and $\boldsymbol{u}_{it} = \mathbf{A}_i(0)\boldsymbol{\epsilon}_{it}$ to obtain, respectively, the estimated structural common and composite shocks. Subsequently, we calculate simple correlations between the estimated common and composite structural shocks to compute the

[11] This recursive identification scheme has been previously implemented by Bernanke & Blinder (1992), Christiano, Eichenbaum & Evans (1996), Rotemberg & Woodford (1997), and Christiano, Eichenbaum & Evans (1998a) to assess monetary policy shocks under a macroeconomic perspective. Nonetheless, the extension of the structural VAR methodology to a panel setting, as proposed by Pedroni (2013), allows its implementation to investigate regional dynamics.

[12] The impulses responses within the matrix $\mathbf{A}_i(L)$ are related to the structural parameters matrix $\boldsymbol{B}_i{}^{-1}$ by means of the following equalities: $\mathbf{A}_i(L) = \mathbf{F}_i(L)\boldsymbol{B}_i{}^{-1} = \boldsymbol{B}_i{}^{-1} + \mathbf{F}_{i1}\boldsymbol{B}_i{}^{-1}L + \cdots + \mathbf{F}_{ij}\boldsymbol{B}_i{}^{-1}L^j = \mathbf{R}_i(L)^{-1}\boldsymbol{B}_i{}^{-1} = \left(\boldsymbol{I} - \sum_{j=1}^{p}\mathbf{R}_{ij}L^j\right)^{-1}\boldsymbol{B}_i{}^{-1}$, thus implying that $\mathbf{A}_i(0) = \boldsymbol{B}_i{}^{-1}$ at lag $p = 0$.

[13] The common components or time effects are defined as $\Delta \bar{\boldsymbol{z}}_t = N^{-1}\sum_{i=1}^{N}\Delta \boldsymbol{z}_{it}$, that is, the average over the N=32 Mexican states for each quarter in the sample period.

elements of the loading matrix Λ_i. Afterwards, by using the common factor representation in $\boldsymbol{\epsilon}_{it} = \Lambda_i\, \bar{\boldsymbol{\epsilon}}_t + \tilde{\boldsymbol{\epsilon}}_{it}$, we estimate the idiosyncratic structural shocks as the regression residual $\tilde{\boldsymbol{\epsilon}}_{it}$ and compute the state-specific idiosyncratic impulse responses.

6. Database and summary statistics

The structural panel VAR system consists of the 32 cross-section units corresponding to the Mexican states and a sample time spanning from 2003 to 2022 on a quarterly frequency. The state manufacturing output level (mp_{it}) is measured by using the Monthly Indicator of Industrial Activity by State (IMAEF by its acronym in Spanish language) which summarizes manufacturing firms behaviour by constructing a volume index. The IMAEF statistical information is publicly facilitated by the National Institute of Statistics and Geography (INEGI by its acronym in Spanish). Both types of employment, permanent (pe_{it}) and temporary (te_{it}) ones, are measured by the monthly number of employees laboring in manufacturing activities, which registers are publicly accessible at the Mexican Institute of Social Security (IMSS by its acronym in Spanish) database.[15]

In Table 1, a summary of descriptive statistics calculated on the panel data shows that the average number of permanent workers is considerably higher than its temporary counterpart. The standard deviation to mean ratio exhibits, in addition, a marked difference between the magnitudes of dispersion individually calculated for each type of employment, which suggests temporary employment is more dispersed around its state mean than permanent employment is. The output index has an average level of 101.6 and a low dispersion as the calculated ratio of standard deviation to mean equates 8.0%.

Table 1.
Summary statistics

Statistic	mp	pe	te
Average	101.6	123959	16497
Std. Dev.	8.0	131479	18319
Std. Dev./Average	8.0%	106%	111%
Max	126.6	386694	80556
Min	90.6	6068	1235

mp denotes total manufacturing output; pe and te refers to permanent and temporary employment in manufacturing production, respectively.
Source: own calculations with information from INEGI and IMSS databases.

7. Empirical evidence

This section reports the empirical findings based on the dynamic structural responses derived from the three-variate structural panel VAR according to the practical estimation procedure that was described in the preceding methodology section.[16] Specifically, on the one hand, our estimates suggest that idiosyncratic output shocks are relevant for employment although in different magnitude. In particular, the cumulative structural responses indicate that both permanent and temporary employment would experience an augmentation, although of different proportion, in 13 states out of 32 towards the end of a

[15] Quarterly data were obtained as the average of the corresponding monthly figures.
[16] This procedure required, first, estimating the reduced form of one common panel vector autoregression and 32 composite vector autoregressions whose number of parameters and associated statistics is too large to be reported in the text, but these estimates are available upon request. The lag length was selected individually for each vector autoregression when, by inspection, at least two of the statistics provided by the Akaike information criteria, the Bayesian information criteria, and the general-to-specific approaches were generally coincident. A summary of the selected lag length for each vector autoregression is also available in Tables A1 and A2 in the Appendix.

twelve-quarter impact period.[17] Whilst, there is evidence of combined patterns in a second group comprised by 14 states, where temporary employment increases, but permanent employment decreases, and vice versa. Only in 5 states the net effect summarized in the cumulative dynamic responses manifestly suggest a decrease in total employment following a positive idiosyncratic output shock.

Regarding the interaction between both types of employment, and under the rationale that firms engage in recruiting employees on a permanent basis once the demand for their products is believed to keep stronger, an increase in the number of permanent employees may be accompanied by an augmentation or a decline in the number of temporary employees depending on whether firms aim to implement a complementation or substitution strategy between them. The estimated dynamic responses depicted in Figure 1 indicate that both types of strategies are implemented, although manufacturing firms in 21 out of 32 states would be disposed to substitute temporary by permanent employees. As might be expected, however, our estimations suggest the substitutional reallocation of temporary by permanent employment is rather heterogeneous across states. In the state of Zacatecas, for example, an unexpected positive shock on the number of permanent employees would initially induce a reduction in the number of temporary employees by 7.17% at the end of the twelve-quarter impact period.

Moreover, virtual particularities in the trajectories of the estimated dynamic responses suggests variations in the implementation of the substitution strategies. In this respect, after the initial permanent positive employment shock, manufacturing firms in the states of Aguascalientes, Guerrero and Veracruz would intensify the substitution of temporary employment, while in a second group of states, such as Coahuila, Colima, Michoacán, Puebla, Jalisco, Campeche, Oaxaca, Estado de México, Guanajuato, Hidalgo, Tlaxcala, Nuevo León and San Luis Potosí, the estimated magnitudes of the substitutive cumulated impact are smaller, ranging from -0.93 to -0.24, at the end of impact horizon. Concerning the opposite strategy, our estimations in Figure 1 suggest that manufacturing firms in 11 states would be inclined to recruit additional temporary employees; notably, the state of Tabasco, which would experience the largest complementation impact.

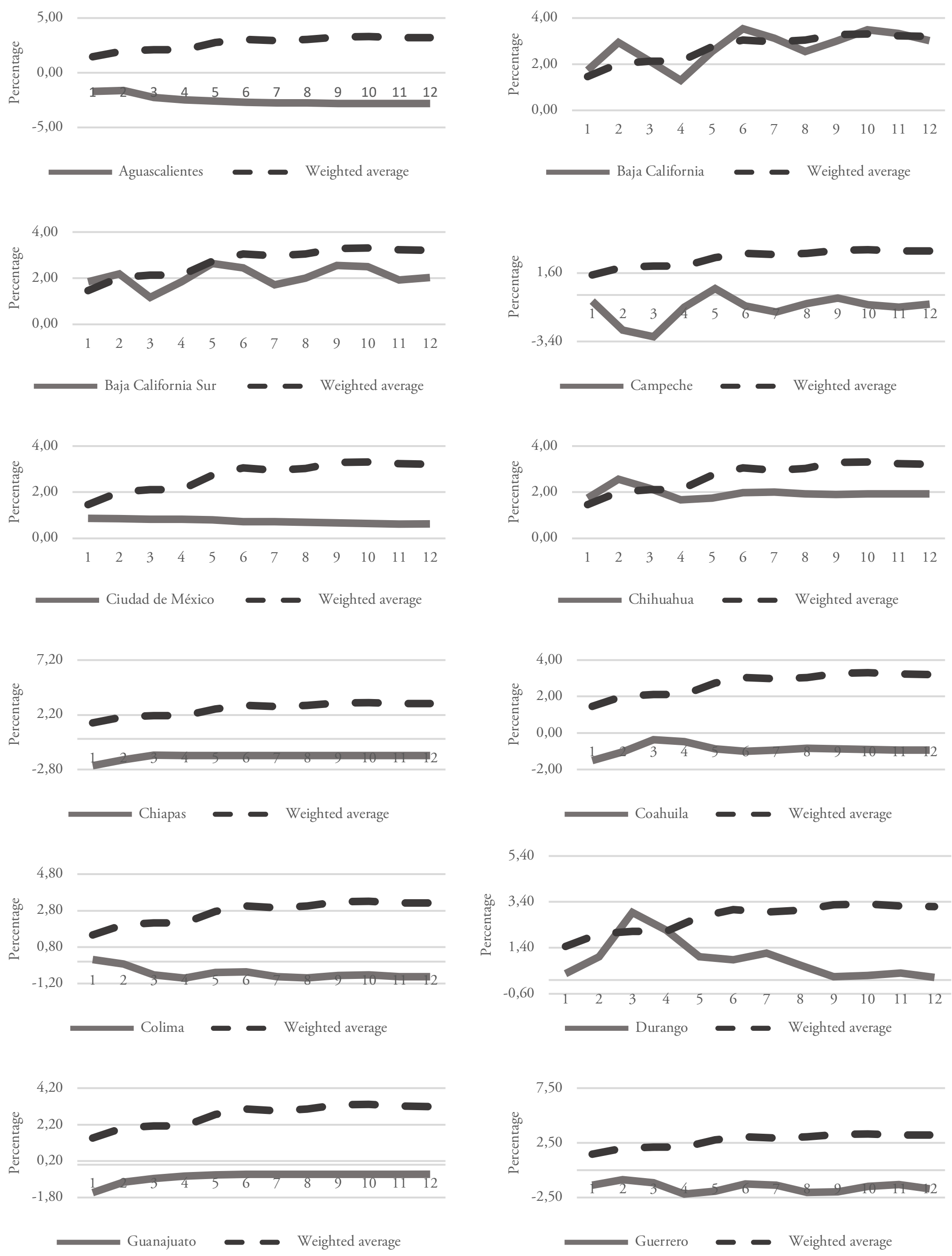
In turn, Figure 2 shows that an unexpected positive shock on the number of temporary employees would similarly induce a mix of positive and negative patterns of responses on permanent employment levels across states. Accordingly, manufacturing firms in 16 out of 32 states would be willing to recruit additional permanent employees, yet the estimated magnitudes of the impacts are rather heterogenous ranging from figures as small as 0.05% and up to 1.4% during a twelve-quarters period. In the states of Zacatecas and San Luis Potosí, for example, whose manufacturing industries contribute importantly to their total gross state production, their number of permanent employees would respectively augment by 1.4% and 1.3%. Our estimations supplementarily indicate that in 14 out of 32 states manufacturing firms located within these states would rather engage in strategies that substitute permanent by temporary employees. In this group of states, whose dynamic responses range from -0.02 to -0.95, Tamaulipas and Tlaxcala would exhibit the largest negative impact on their number of permanent employees.

Moreover, conjoining the empirical results from both Figures 1 and 2 is useful to consolidate our understanding regarding the prevailing combination of complementation and substitution strategies that manufacturing firms across states would likely implement when recruiting decisions are involved. A summary presented in Table A3 indicates that four general patterns of strategies would emerge when combining firms' recruiting decisions across states: 1) A double complementation strategy, which imply that manufacturing firms in six states would be disposed to recruit additional employees on temporary or permanent bases to accompany an initial increase in their employment level due to the corresponding positive employment shock. 2) A double substitution strategy, which consists in prescinding of temporary or permanent employees to be substituted by employees initially recruited due to the corresponding positive employment shock, would describe the behavior of manufacturing firms in ten states. 3) A strategy that combines both complementation and substitution in firms' recruiting decisions can be divided into two specific strategies according to the type of employment that is being substituted or complemented: a combination strategy that consists in rescinding temporary employees to be substituted by permanent employees or recruiting additional permanent employees in complementation of temporary ones,

[17] Because of space limitation, these cumulative impulse response functions are only available upon request.

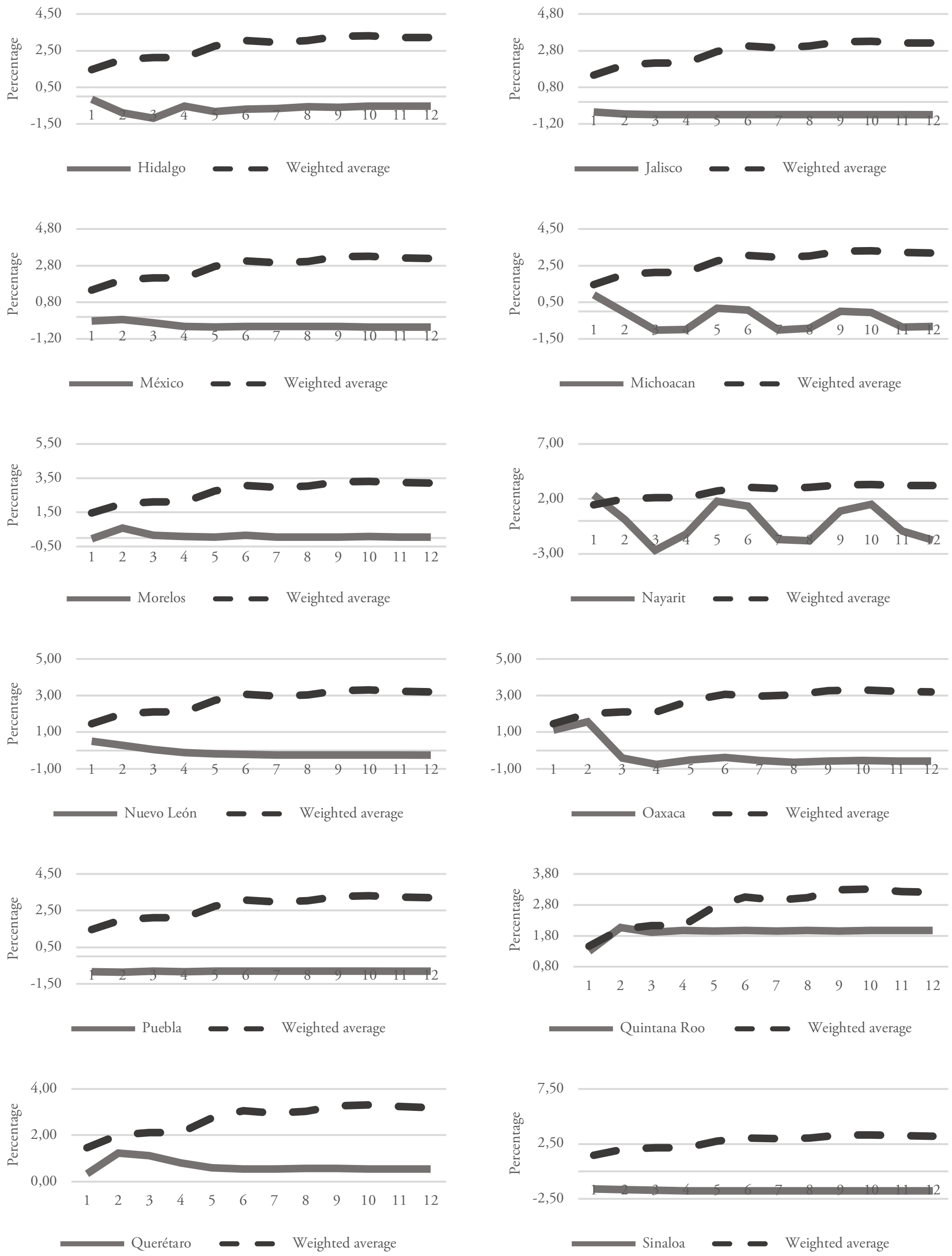
depending on the corresponding positive employment shock, would be characteristic of manufacturing firms in eleven states. The converse combination strategy was found only in five states notwithstanding.

FIGURE 1.
Cumulative response estimates of temporary manufacturing employment (te) to a permanent employment (pe) idiosyncratic shock



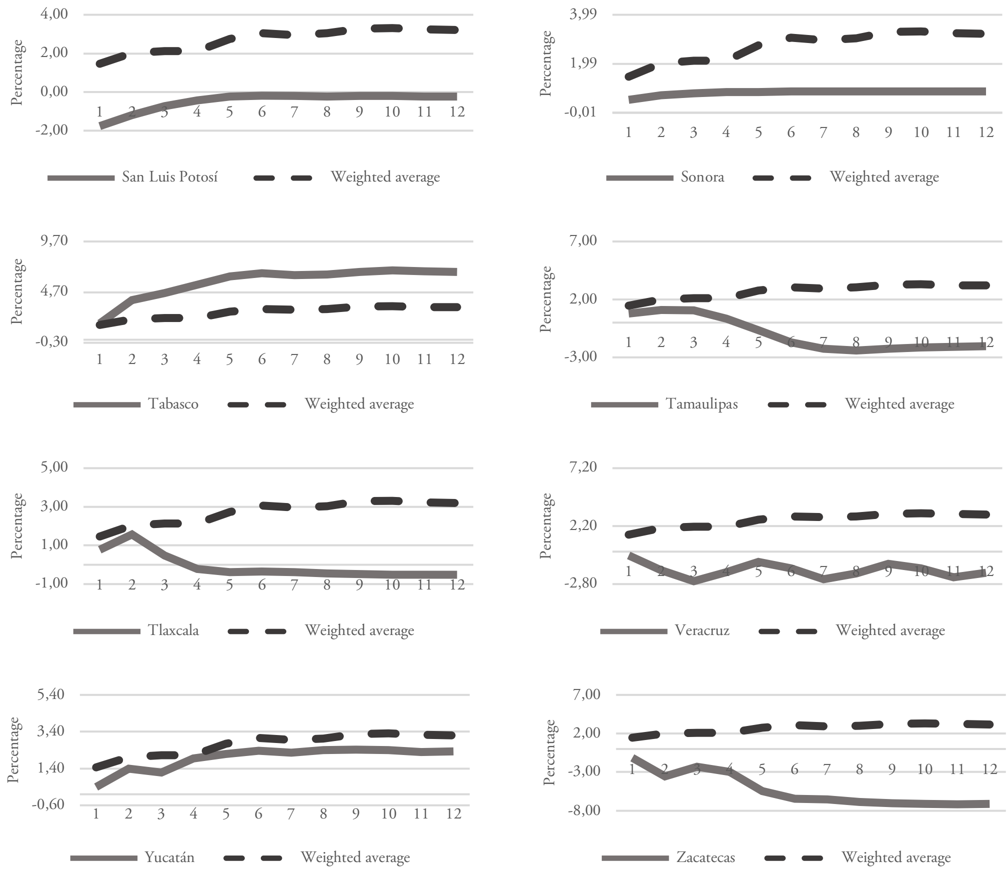
Source: own estimations.

FIGURE 1. CONT.
Cumulative response estimates of temporary manufacturing employment (te) to a permanent employment (pe) idiosyncratic shock (continuation)



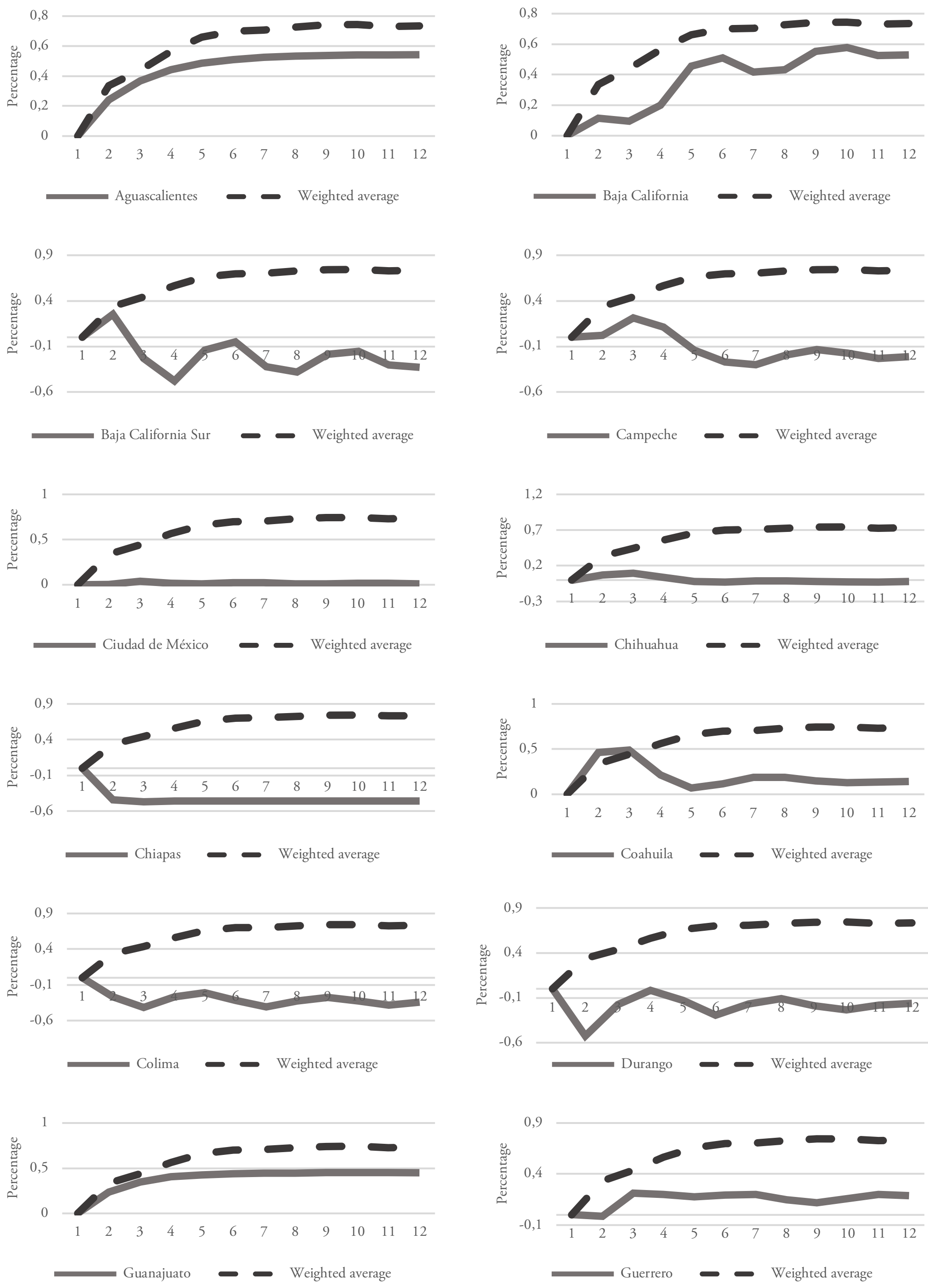
Source: own estimations.

Figure 1. cont.
Cumulative response estimates of temporary manufacturing employment (te) to a permanent employment (pe) idiosyncratic shock (continuation)



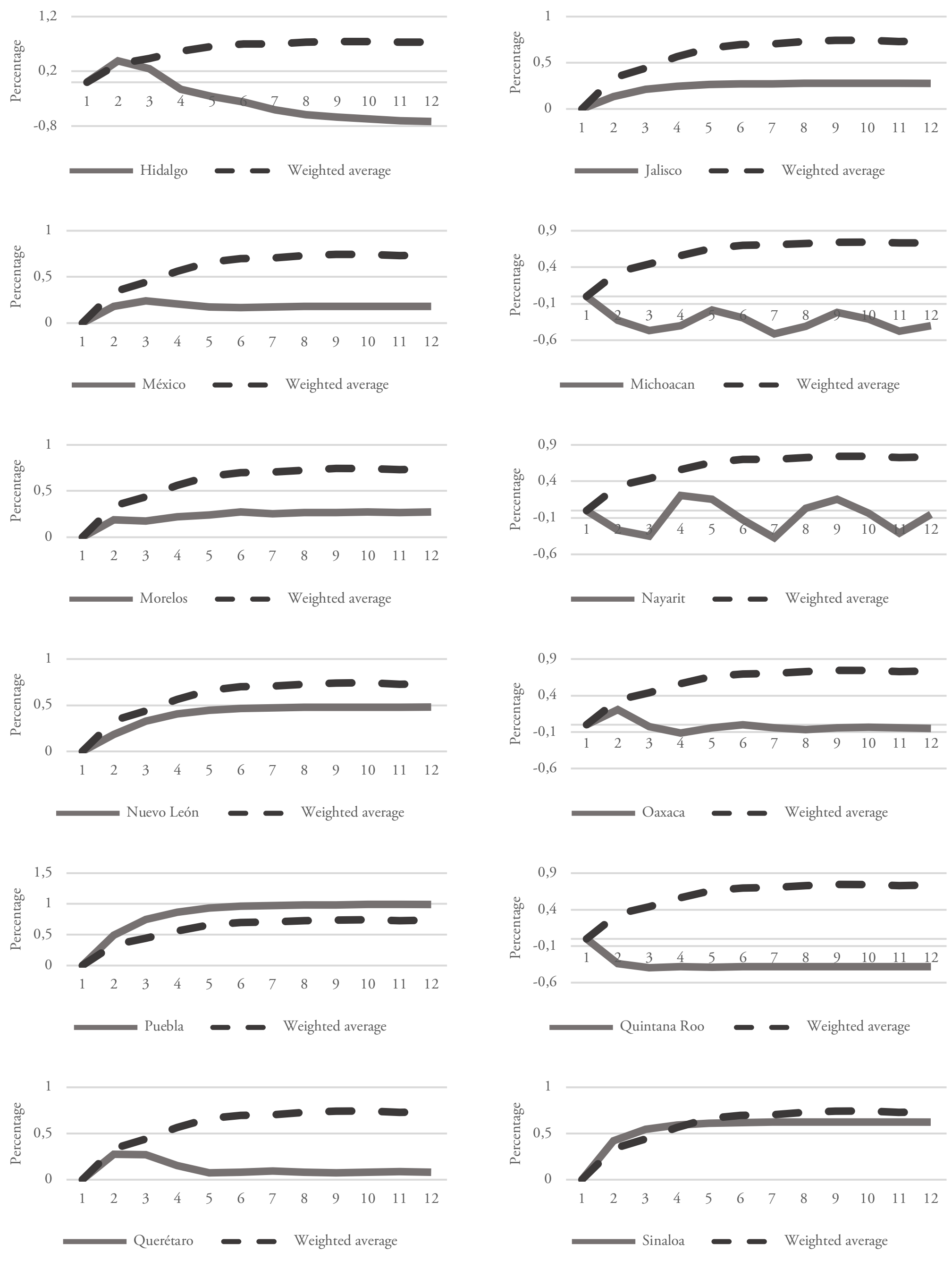
Source: own estimations.

FIGURE 2.
Cumulative response estimates of permanent manufacturing employment (pe) to a temporary employment (te) idiosyncratic shock



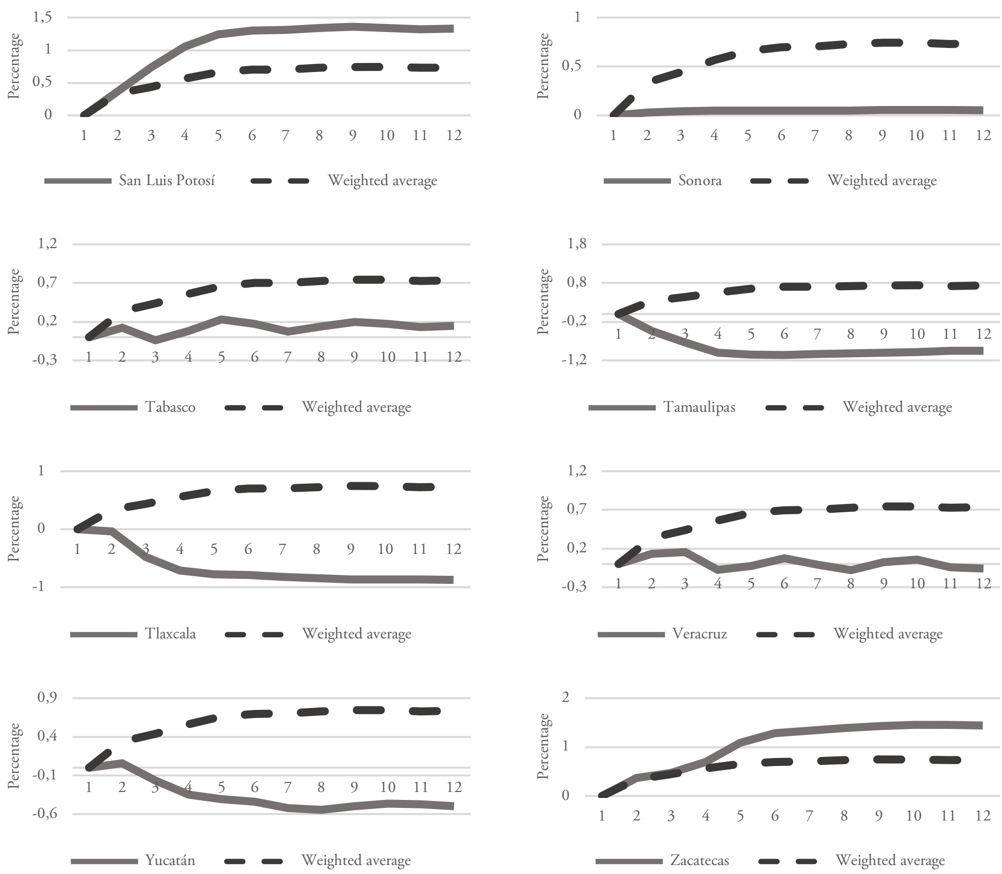
Source: own estimations.

FIGURE 2. CONT.
Cumulative response estimates of permanent manufacturing employment (pe) to a temporary employment (te) idiosyncratic shock (continuation)



Source: own estimations.

Figure 2. cont.
Cumulative response estimates of permanent manufacturing employment (pe) to a temporary employment (te) idiosyncratic shock (continuation)



Source: own estimations.

8. Robustness analysis

This section reports a variety of robustness analysis performed with the intention of verifying whether our empirical findings would differ both qualitatively and quantitatively, when some modelling assumptions are modified.[18] In this regard, our first robustness test consisted in inverting the assumptions behind the imposed contemporaneous restrictions on the interaction between both types of employment, which required changing the order of the first two endogenous variables. The responses estimates based on this modelling variant are found to be rather like our initial estimates both qualitatively and quantitively, though we find it is more plausible assuming the initial set of contemporaneous restrictions under the economic rationale expressed in the text.[19]

Our second test consisted in assessing the sample sensitivity of our estimations due to the presence of events or policy variations that might have induced instability in the estimated parameters. After a careful examination of the events and policy variations that might have influenced the stability of our estimates during the sample timeframe, we regarded the implementation of the labor policy reform starting

[18] The estimated structural responses of this robustness analysis are available upon request.
[19] We are aware that another potential modification consists in assuming that demand-driven output shocks may induce contemporaneous impacts on both types of employment, however, it was discarded because this assumption does not induce any modification in the interaction between both types of employment which is central to our research.

in November 2012 as the only most likely potential source of change in the behavior of firms that consequently might have been reflected in our estimates. The procedure of our sample sensitivity test consisted thus, first, in regressing each type of employment on a dummy variable which is defined with ones from December 2012 onwards, and zeros placed in the remaining positions. Then, the residuals obtained from these regressions were used in place of the corresponding temporary and permanent employment data to deliver a new set of structural idiosyncratic impulse responses which, subsequently, were compared with the initial set of structural idiosyncratic impulse responses to assess any discrepancy between both. We found negligible differences between both sets of structural dynamic responses which attests the stability of our initial estimates to sample variation[20].

A third set of tests were performed with the intention of assessing the sensitivity of our estimates to modifications in the lag length structure of the VAR models. The specific procedure involved choosing an alternative lag length to that suggested by our adopted selection criteria only in the cases when at least one of the GTOS, BIC and AIC statistics is discrepant in pointing towards the same lag length. The procedure conducted us in the estimation of 22 dynamic responses which estimates are found to be sensitive, particularly when the alternative lag length is distantly shorter than our initial lag length structure, often showing a tendency to unsettle as the impact period goes farther which can be attributed to a lag length misspecification.

9. Conclusions

This study aimed to investigate the relationship between permanent and temporary employment by using statistical information for the manufacturing sector in the thirty-two Mexican states. Whereas some recent studies have paid a rising interest on the possibility that recent labor-market flexibilization policies may have led to precarious labor conditions for workers, none of them have studied whether firms within states would induce a substitution or complementation strategy between both labor dimensions. Based on a structural panel vector autoregressive system, which accommodates the heterogenous nature of state data and helps to isolate structural shocks to the labor variables, our empirical results show a heterogenous implementation of the labor market reforms across the Mexican states. Our results evince that manufacturing firms across some states would implement a double substitutive or complementation strategy between both types of employment while others would follow a combination strategy. Our estimations additionally show these responses are rather asymmetric as temporary jobs seem to be more sensitive to variations in permanent jobs than the opposite, a result that may reflect the characteristics of the corresponding labor contracts. Regarding the states' dynamic response of employment to variations in the output level, the empirical evidence encompasses the economic theory prediction that both types of employment would increase, although in some states manufacturing firms would be inclined to increase one type of employment apparently at expenses of the other. In addition, our empirical results have some practical implications from a policy perspective as they suggest the strategic rationale by which manufacturing firms across states intend to benefit from the recent labor market reforms which, in the eve of increasing concerns regarding worsening labor conditions in México, our results may prove useful to evaluate a reorganization of the incentives for promoting a complementation strategy between both types of employment that simultaneously encourage permanent posts, the quality of temporary employment and its transition to indefinite contractual labor arrangements. Further investigation needs to be done yet, focusing on the determinants and effects of both types of employment.

[20] A second sample sensitivity test was performed discarding the data from years 2020, 2021 and 2022 which allowed us to assess whether the observed initial contraction in the manufacturing sector due to the implementation of sanitary measures intended to restrain the COVID 19, and the subsequent recovery in the manufacturing activity, might have induced significant instability in the estimated parameters. After comparison, our findings suggest minor differences between both the initial and new sets of estimated dynamic responses, which supports the robustness of our estimates.

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Appendix

Table A1.
Lag length selection summary for the reduced common component vector autoregression

Lags	GTOS (Chi-squared test)	Lags	BIC	Lags	AIC
0	0	0	-13,89	0	-13,98
1	86.87*	1	-14.53*	1	-14.88*
2	8,87	2	-14,13	2	-14,72
3	7,54	3	-13,71	3	-14,51

Source: own calculations.

TABLE A2.
Lag length selection summary for the reduced form composite vector autoregressions

State name	GTOS (Chi-squared test)	Lag	BIC	Lag	AIC	Lag	Chosen lag
Aguascalientes	57,4633848	1	-8,8244779	1	-9,1756533	1	1
Baja California	38,4081588	3	-10,218249	1	-10,994395	3	3
Baja California Sur	67,5048303	3	-8,6641213	3	-9,4632815	3	3
Campeche	31,6305338	3	-8,5936663	0	-9,0953968	3	3
Ciudad de México	28,3605214	3	-12,147302	3	-12,946463	3	3
Chihuahua	19,4647628	2	-9,8703139	1	-10,221489	1	2
Chiapas	20,9398338	1	-9,139957	0	-9,2522317	1	1
Coahuila	36,8816548	2	-9,56618	1	-10,128044	2	2
Colima	71,8164898	3	-9,1335095	3	-9,9326697	3	3
Durango	26,5088837	3	-9,9972654	0	-10,322405	3	3
Guanajuato	86,7990924	1	-11,287349	1	-11,638524	1	1
Guerrero	40,5153607	3	-9,8938018	1	-10,529714	3	3
Hidalgo	17,0398279	3	-9,8282632	1	-10,179439	1	3
Jalisco	27,8342527	1	-12,697011	0	-12,901211	1	1
México	18,3612203	2	-12,443928	1	-12,795104	1	2
Michoacan	26,5653479	3	-9,2685434	2	-9,9038097	3	3
Morelos	42,3898054	2	-11,750651	0	-12,137222	2	2
Nayarit	103,855792	3	-7,0231924	3	-7,8223526	3	3
Nuevo León	67,8081112	1	-12,266871	1	-12,618046	1	1
Oaxaca	30,3259532	2	-8,6573325	0	-8,7684691	2	2
Puebla	56,3865996	1	-9,3308901	1	-9,6820655	1	1
Quintana Roo	21,4577657	1	-6,847624	0	-6,9668044	1	1
Querétaro	64,3130841	2	-10,833988	2	-11,422195	2	2
Sinaloa	36,3871044	1	-9,8277712	0	-10,146009	1	1
San Luis Potosí	30,6518611	3	-11,417164	1	-11,980205	3	3
Sonora	37,4245321	1	-9,3314012	0	-9,6634719	1	1
Tabasco	23,6756712	3	-8,7818205	0	-9,1280151	3	3
Tamaulipas	34,7002856	3	-11,561094	1	-12,031816	3	3
Tlaxcala	17,08232	2	-9,2721992	1	-9,6233747	1	2
Veracruz	21,3994254	3	-10,973775	2	-11,561982	2	3
Yucatán	42,240229	3	-10,533797	1	-10,950371	3	3
Zacatecas	28,1113818	3	-6,7161464	0	-7,1293429	3	3

Source: own calculations.

Table A3.
Summary of the cumulated permanent and temporary employment responses to their respective employment shocks and associated complementation and substitution strategies across the Mexican states

State	Resp. of temporary employment	Strategy	Resp. of permanent employment	Strategy
Tabasco	6,7	Complementation	0,15	Complementation
Baja California	3,03	Complementation	0,53	Complementation
Sonora	0,86	Complementation	0,05	Complementation
Ciudad de México	0,63	Complementation	0,01	Complementation
Querétaro	0,54	Complementation	0,08	Complementation
Morelos	0,06	Complementation	0,27	Complementation
Yucatán	2,34	Complementation	-0,5	Substitution
Baja California Sur	2,03	Complementation	-0,33	Substitution
Quintana Roo	1,96	Complementation	-0,38	Substitution
Chihuahua	1,93	Complementation	-0,02	Substitution
Durango	0,11	Complementation	-0,16	Substitution
Tlaxcala	-0,52	Substitution	-0,87	Substitution
Hidalgo	-0,52	Substitution	-0,72	Substitution
Oaxaca	-0,59	Substitution	-0,05	Substitution
Campeche	-0,69	Substitution	-0,21	Substitution
Michoacan	-0,81	Substitution	-0,4	Substitution
Colima	-0,83	Substitution	-0,34	Substitution
Chiapas	-1,55	Substitution	-0,46	Substitution
Nayarit	-1,74	Substitution	-0,05	Substitution
Veracruz	-1,85	Substitution	-0,06	Substitution
Tamaulipas	-2,03	Substitution	-0,95	Substitution
San Luis Potosí	-0,24	Substitution	1,33	Complementation
Nuevo León	-0,25	Substitution	0,48	Complementation
Guanajuato	-0,52	Substitution	0,45	Complementation
México	-0,54	Substitution	0,18	Complementation
Jalisco	-0,7	Substitution	0,28	Complementation
Puebla	-0,81	Substitution	0,99	Complementation
Coahuila	-0,93	Substitution	0,14	Complementation
Guerrero	-1,72	Substitution	0,19	Complementation
Sinaloa	-1,77	Substitution	0,62	Complementation
Aguascalientes	-2,81	Substitution	0,54	Complementation
Zacatecas	-7,14	Substitution	1,44	Complementation

Source: own elaboration with information from Figures 1 and 2.