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The economics of pandemics: Effects, measures and economic perspectives in the face of the COVID-19 pandemic in the manufacturing sector in Mexico

La economía de la pandemia: efectos, medidas y perspectivas económicas ante la pandemia de la COVID-19 en el sector manufacturero de México

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Abstract

The objective of this investigation consists in analyzing the effects that some measures intended to content the 19-nCoV pandemic may exert in the functioning of the Mexican manufacturing sector. In particular, by means of implementing an autoregressive economic-epidemiologic vector model aimed to approach the observed effects after the rise in number of contagions, it is analyzed the dynamic effects of unexpected variations in key economic variables. Emphasis is paid in the responses of consumption, employment and production in the manufacturing sector through counterfactual analysis since the month the pandemics begun in Mexico. Results suggest incentivizing consumption with adequate economic measures and sanitary protocols may contribute to stabilizing the economy. A notable result suggests that rises in the number of diseases cases with potential damage to human health, similar to that of the 2019-nCoV, would directly harm the economy.

JEL Code: C54, J40, I10, E32, E37, L60
Keywords: economics of pandemics; COVID 19; economic effects; counterfactual analysis; Mexico

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Resumen

El objetivo de esta investigación consiste en analizar los efectos que algunas medidas de contención de la pandemia de la COVID 19 pudieron ejercer en el funcionamiento del sector manufacturero mexicano. En particular, mediante un modelo económico-epidemiológico de vectores autorregresivos que busca aproximar la secuencia de efectos observados ante el brote de contagios, se analizan los efectos dinámicos de variaciones inesperadas en variables económicas clave. Se enfatiza la respuesta del consumo, empleo y producción en el sector manufacturero través de un análisis contrafactual a partir del mes en que inicia la pandemia en México. Los resultados sugieren que el consumo es una variable que, incentivada mediante medidas económicas y protocolos de seguridad sanitaria adecuados, puede contribuir a la estabilización de la economía. Un resultado notable sugiere que los brotes de enfermedades con un daño potencial a la salud humana similares a la COVID 19, tendría efectos negativos directos en la economía.

Código JEL: C54, J40, I10, E32, E37, L60
Palabras clave: economía de la pandemia; COVID 19; efectos económicos; análisis contrafactual; México

Introduction

Pandemics, whose characteristic is the international, regional, or local spread of disease, become significant when it is discovered that they have potentially harmful effects on human health[1], forcing international health authorities and national governments to implement action plans to contain their transmission. At the end of 2019, a new global pandemic emerged associated with an infectious disease caused by an unknown coronavirus named COVID-19, whose capacity for human-to-human transmission and potential damage to health were detected almost immediately.

In response, the World Health Organization (WHO) developed an initial comprehensive pandemic preparedness strategy that included an action plan to contain international transmission of COVID-19 (WHO, 2020) and subsequently updated it once more was known about its mode of transmission (WHO, 2020). In the first of these response plans, while it was stated that COVID-19 can cause severe harm to human health, including death, it was also recognized that containment measures were underpinned by wide uncertainty about the transmissibility and clinical spectrum of the disease. However, it was also noted that some of these measures, such as the imposition of mobility restrictions, are recommended when there is uncertainty about the behavior of the disease. The second response plan included the recommendation of various physical distancing measures and mobility restrictions, including

[1]The global influenza A (H1N1) pandemic, which began in the first half of 2009, caused a mortality rate of 0.01% of the world population in the first year (Dawood et al., 2012), making it one of the least deadly pandemics in the world (Dawood et al., 2012).

the closure of non-essential workplaces, limited use of public transport, domestic and international travel restrictions, and quarantines (WHO, 2020).

Although these measures primarily focus on containing a health problem, it is recognized that they impose a social and economic cost on the countries that implement them (WHO, 2020), thus posing a temporary trade-off between the reduction of disease transmissibility and the performance of the economy. However, although this apparent trade-off is temporary, its transition toward lifting physical distance and mobility restrictions that do not favor economic recovery will depend on the capacity of governments and society to contain transmission through prevention measures.

In the case of Mexico, the crude case fatality rate resulting from COVID-19 infection has reached nearly 11%, making it one of the countries whose population, once infected by this disease, has a higher probability of dying. To contain the number of infections and the fatality rate, since mid-March 2020 the federal government has implemented a set of actions that reflect the WHO's proposed measures. These confinement and mobility restrictions measures had an almost immediate impact on the functioning of the Mexican economy and were noticeable in the labor market and economic activity. A general review of the reported figures indicates that as measured by the Global Indicator of Economic Activity (IGAE), general economic activity fell by 1.3% between February and March of this year, with an accumulated drop of 1.8% since January. Additionally, the specificity of these measures is reflected in a differentiated manner in the performance of the economic sectors; for example, the construction sector reduced its activity by 1.4% in this same period; but sectors such as manufacturing, leisure and recreation services, and tourism registered contractions, including 26% in the latter case.

Companies, which had to implement measures to face the initial effects of the changes in purchasing patterns derived from the lockdown measures and reduced mobility, reacted with adjustments in the labor market. These adjustments led to an accumulated contraction of 3.3% of total formal employment between March and April; to substitutions of temporary for permanent work, with an accumulated reduction in the latter component of 6.6% in the same months; and to an increase in the number of hours worked in compensation for layoffs, mainly of blue-collar workers. This explains, in part, how Mexico's business sector has dealt with changes in the functioning of the economy within the framework of the containment measures.

On the other hand, although this general review seems to attribute the economic repercussions entirely to the set of containment measures implemented, it is important to recognize that their effect on the functioning of the economy is indirect. Accordingly, the analysis of the economic implications of the distancing and mobility restrictions requires establishing, in the first instance, the transmission channel through which these measures could have impacted the economy, so that, using the appropriate methodological strategy, it will be possible to identify and quantify the dynamic sequence of effects.

Thus, a plausible transmission mechanism would recognize, for example, that in response to an abrupt increase in the number of infections, subsequent containment measures would first have a direct effect on consumption decisions due to a decrease in the use of public transportation and quarantines, among other measures, with a potentially negative effect on business sales. Consequently, companies would initially react to the observed changes in consumption with adjustments to the number of workers. However, whether or not to lay off workers, and if so, how many workers to lay off, is the decision of the economic agents involved. These measures are not part of the established containment measures. Similarly, the indirect effect of COVID-19 containment measures can also be traced back to the production decisions of the economic agents.

In this context, this research aims to analyze the economic repercussions of the COVID-19 containment measures in Mexico. In particular, the aim is to establish an explicit transmission mechanism in order, through the appropriate methodological strategy, to identify and quantify the effects of these measures on the performance of the Mexican manufacturing sector. However, because the distancing and mobility restrictions distinguished between essential and non-essential economic activities, some sectors were more affected than others in terms of the economic decisions about consumption, hiring of personnel, and production associated with these containment measures. Accordingly, the research will analyze the response described by some key economic variables of the manufacturing sector. This sector has contributed approximately 27% to national employment in the last 20 years, as well as direct and indirect economic effects due to its productive integration with other sectors.

The specific questions guiding this research are: What effect did the containment measures have on the consumption of manufacturing goods? Would economic and public health measures that encourage safe consumption for human health contribute to stabilizing the functioning of the manufacturing sector? Could the increase in the number of infections by contagious diseases, such as COVID-19, directly affect the dynamics of consumption, employment, and production in the Mexican manufacturing sector? This research uses a recursive vector autoregressive model to model the economic-epidemiological interaction, which provides the possibility of counterfactual answers to these questions. Accordingly, through the implementation of an economic-epidemiological model, this research aims to contribute to understanding the repercussions that sudden increases in infectious diseases can cause in key variables of the Mexican manufacturing sector economy, adding empirical evidence to the set of international studies that have recently focused on analyzing the economics of the pandemic in different countries. Furthermore, counterfactual empirical evidence is provided for the potentially stabilizing effect of implementing economic policy measures to encourage manufacturing consumption, the practical implications of which are useful in guiding the economic management of the COVID-19 pandemic while it is still unfolding.

This article is organized as follows: after establishing the objective and motivation of this research, the next section reviews some recent economic studies that address the implications of COVID-19. The next section provides an overview of some of the recent developments in the COVID-19 pandemic and the main changes observed in the functioning of the Mexican manufacturing sector. Next, there is an explanation of the methodological strategy implemented in the research. Then, in the following section, there is an analysis of the findings of the economic effects observed and some economic policy measures that may be useful for the economic stabilization of the manufacturing sector. The conclusions highlight the main economic implications and some perspectives on the so-called new normal for the functioning of the economy.

Literature review on the economic implications of COVID-19

Unlike the AH1N1 influenza pandemic, which began more than ten years ago, the monitoring of the COVID-19 pandemic has been carried out with greater attention in real time due to the greater availability of information technologies in the affected countries and its higher mortality rate. This provides the opportunity to access similar monitoring of the performance of economies as the pandemic progresses.

Economic studies on the implications of the pandemic cover most countries, and early on, they address the possible effects on economic fundamentals, recommendations for economic policy actions, and more recently, changes in consumption patterns and unequal effects on labor markets, among many other aspects.

Anderson (2020) warned that China, the country that officially registered the first case of COVID-19, would face a possible economic contraction greater than that observed up to April 2020 due to the decrease in labor mobility, tourism, and entertainment services. However, the author considered that support measures for the small and medium-sized business sector and fiscal measures, such as corporate tax cuts, with a combined magnitude of 2.5% of the country's gross domestic product, could be sufficient to reduce the negative effects on the economy.

Similarly, some macroeconomic proposals suggested implementing broad monetary and fiscal measures. Galí (2020), who supports this view, argues that the lockdown measures, mobility restrictions, and closure of various economic activities will directly affect the economy through two types of channels. These are supply shocks due to limitations in the access to productive factors and demand shocks through forced changes in consumption habits. The author proposes implementing a "Helicopter" type monetary policy measure, which involves the issuance of money according to the health needs of the member countries of the European Union. This strategy would consist of a transfer from the Central Bank to governments, in a magnitude similar to the purchase of public debt by the bank; however, the author recognizes that this measure could be ineffective if it leads to inflationary biases.

Gopinah (2020), who identifies similar disruptive supply and demand effects, suggests implementing economic policy measures focused on specific segments of the economy. In particular, the author suggests interest rate decreases, the provision of liquidity by the central bank to commercial banks to help them provide financing to companies, mainly small and medium-sized ones, and fiscal stimuli aimed at aggregate demand.

As the pandemic spread worldwide, the availability of information made it possible to carry out more detailed studies on the magnitude and scope of its economic effects. Several studies indicate that labor markets have been some of the most affected. In this regard, Coibion et al. (2020), who studied a large-scale panel survey for families in the United States, mention that job losses have been much greater than those recorded in new unemployment claims. Meanwhile, in a more recent study for the United States, Cajner et al. (2020) found that, in May 2020, there was a rebound in employment in small businesses through a new call for employees. However, the authors document that job loss is still high in the country's lowest quintiles of wage levels, attributing to COVID-19 an uneven contractionary effect on labor markets.

On the other hand, Cox et al. (2020), who had access to information on household bank accounts in the United States, found that household spending contracted for all income distribution strata from March through early April. However, during the pandemic, the lower-income strata experienced a more rapid rebound in liquid asset balances. According to the authors, the initial contraction in spending is attributable to the direct effects of the pandemic but not to labor market imbalances. Baker et al. (2020) analyze a database that records household financial transactions in the same country. Their results suggest that spending on some types of commercial retail goods, credit card payments, and food increased at the beginning of the pandemic, followed by a decline in overall consumer spending. Their results indicate that consumption would respond even earlier in a pandemic situation than other economic variables, such as employment, production, and even investment.

Through the exploratory analysis of information with databases that enable the observation of individual behavior, the different international studies conclude that the effects of containment measures in a pandemic environment would start from direct disturbances in the consumption of final goods and services, with unequal repercussions according to the income stratum of individuals. Some works even argue the importance of implementing countercyclical fiscal and monetary measures. In this case, the study of the economics of the pandemic in Mexico suggests a model that explicitly includes the economic-epidemiological interaction to analyze the effects on the manufacturing sector. The methodology used makes it possible to identify structural shocks and responses based on a mechanism that approximates the sequence and interaction observed in some key economic variables of manufacturing activity in the current pandemic environment. It also quantifies the stabilizing effect that some consumption stimulus measures would have on these economic variables.

Overview of the effects of the COVID-19 pandemic on the mexican manufacturing sector

According to the Secretariat of Health of the Mexican federal government records, in February there were five confirmed cases of COVID-19. Until that month, economic activity in the country had been facing adjustments in the expectations of economic agents regarding a redirection in the components and timing of federal public spending, and the implementation of large-scale production projects, among others. However, this figure increased to approximately 1,928 confirmed cases (Figure 1), forcing federal health authorities to develop and implement a response plan to contain the rapid increase in the number of infections of the new disease in the country.

Per the World Health Organization recommendations, the country implemented a series of measures that initially consisted of reducing physical contact between people through temporary confinement measures, the suspension of activities that by their nature bring people together, such as educational activities, and the reduction of urban mobility. Although the purpose of these measures was to reduce the number of infections and gain time to organize a more robust contingency plan, their impact on the economy began to increase.

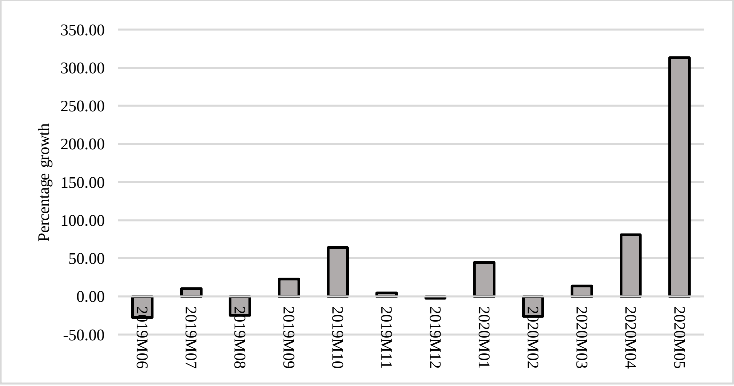

Figure 1. Monthly growth in the number of cases with respiratory diseases and COVID-19
Source: created by the author with information from the federal Secretariat of Health
Note: The months of February through May include cases of pneumonia and COVID-19.

The World Health Organization, in its update of the response plan in support of countries, points out that these measures are temporary, and are even expected to have contractionary effects on the economy, so it recommends measures that balance health care with the gradual reopening of the economy (WHO, 2020). The increase in COVID-19 cases can be considered surprising because the infection rates, clinical pictures, and case fatality rates were still being studied in the different countries affected by the pandemic. For this reason, the channel through which these measures would impact the functioning of the Mexican economy, and their magnitude, were uncertain. In the case of Mexico, the initial lockdown measures would primarily affect household consumption, which had to suddenly modify their purchasing habits at the same time that national mobility decreased. This change in purchasing habits was reflected in a contraction of approximately 4% in the consumption of semi-durable goods during March and approximately 75% in the following month (Figure 2).

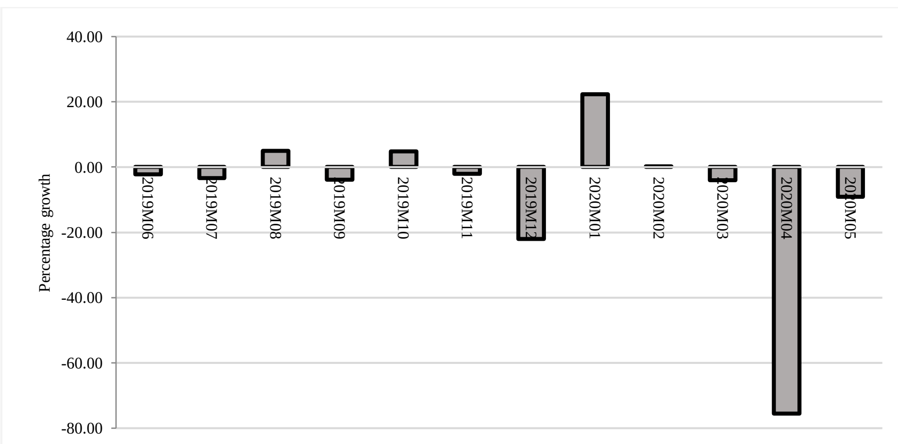

Figure 2. Monthly growth in the Index of Consumption of Semi-durable Goods in Mexico
Source: created by the author with information from INEGI

The effect of these measures seemed to extend to the labor market when, in the same month, there were small contractions in the number of jobs in the manufacturing sector in response to the decrease in the consumption of semi-durables. Thus, in contrast to the increase in the creation of new jobs during January and February of the same year, permanent and especially temporary employment components decreased during March, with a contraction of close to 1% (Figure 3). In the following months, the increase in the number of infections led to a notable increase in the number of confirmed cases of COVID-19 in the country; for example, in April 20,198 new cases were registered, which led to the implementation of even stricter health contingency measures. A program for the temporary closure of economic activities considered non-essential began in the same month, which meant an additional disruption to the economy;

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for example, the consumption of semi-durable goods dropped by 74% (Figure 2), while permanent and temporary manufacturing jobs contracted by 1.7% and 2.7% (Figure 3), respectively.

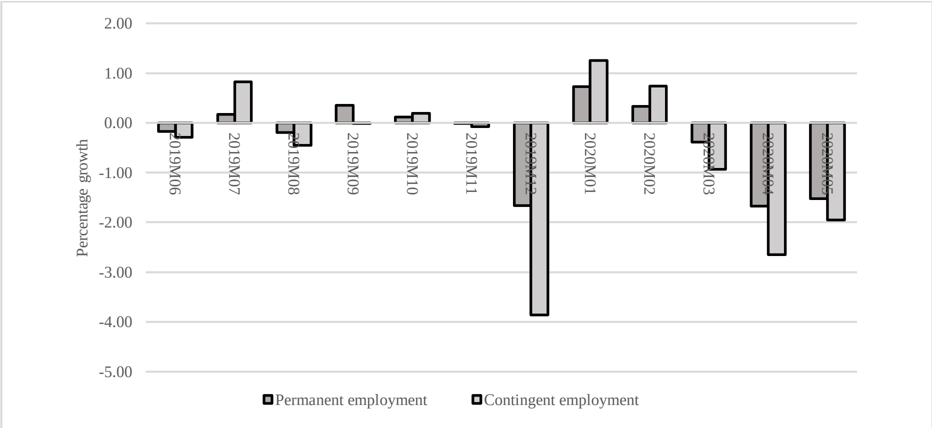

Figure 3. Monthly growth of permanent and temporary manufacturing employment in Mexico
Source: created by the author with information from IMSS

After a period of instability, manufacturing production rebounded in January 2020, and although it contracted again in the following month, this situation ended without negatively affecting the creation of new jobs. In March, when the distancing measures and restrictions on mobility began, there was a slight rebound, which contrasts with the falls in the consumption of semi-durables and manufacturing employment in the same month. In April, companies had to adjust their production plans due to an expected decrease in sales associated with reductions in consumption, which led to a 34% decrease in their operations. Accordingly, the transmission channel of the health containment measures for the operation of the manufacturing sector seems to start with a direct effect on consumption, which, through a decrease in sales expectations, leads to a reduction in the number of jobs, mainly temporary, only to subsequently adjust production in line with these expectations. This mechanism differs from other contractionary episodes in the Mexican economy, not only for the initial reason but also because a rebound in manufacturing economic activity would be expected due to the temporary nature of the containment measures. However, this rebound also depends on adequate countercyclical measures concerning the appropriate component and timing within the identified transmission channel.

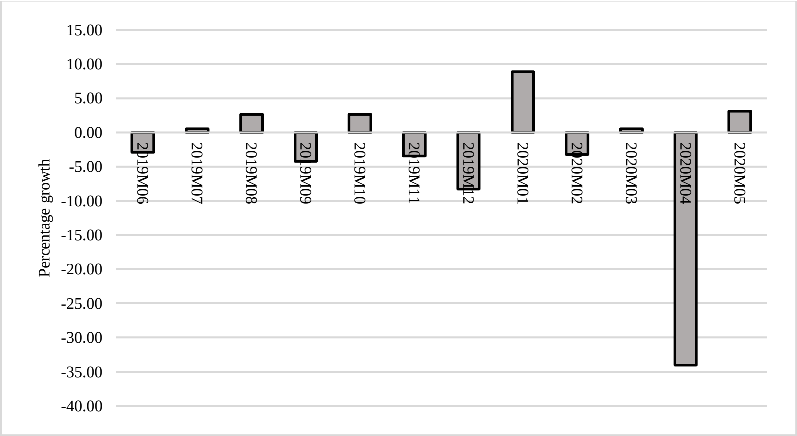

Figure 4. Monthly growth of the General Index of Economic Activity in the manufacturing sector in Mexico
Source: created by the author with information from INEGI

Methodological aspects

This research implemented a methodology based on vector autoregression (VAR) to investigate the repercussions that some of the physical distancing measures and restrictions to personal mobility recently had for the performance of the Mexican manufacturing sector. In particular, it used a vector autoregression approach with recursion, which orthogonalizes the shocks to the economic variables. It constitutes a strategy that makes it possible to establish a causal sequence between these variables and identify their attributable dynamic trajectory in the face of unexpected changes.

Therefore, the specification of the recursive model requires establishing the behavior of economic agents based on their interaction, particularly the response time to changes that could potentially modify this behavior. Accordingly, the proposed specification aims to capture both the facts previously observed in the behavior of consumers and producers in the face of measures to contain the abrupt increase in COVID-19 infections.

In this regard, a plausible transmission channel that makes possible the sequence of events in the face of sanitary containment measures suggests that the first measures of isolation and reduction of mobility could have had a simultaneous effect, in the first instance, on a contraction in consumption. Specifically, the beginning of quarantine periods in March, and the withdrawal of various means of transport, which affected large sectors of the population, could have led to a reduction in purchases, as observed in section 2, with a potentially negative effect on the sales of companies still operating. The behavior of the rest of the economic variables suggests that some companies decided to lay off workers rather than modify their production plans so that they could face a decrease in consumption and consequently in their sales by reducing labor costs. A particular feature of the Mexican manufacturing labor market is that companies use temporary employment to adjust more quickly to cyclical movements in the economy, without this implying that permanent employment may not also be affected. Incorporating these features into the specification of the recursive VAR model is important because it helps clarify economic decisions and the interaction between economic agents.

Additionally, although the reduction in manufacturing production occurred due to the temporary closure of economic activities in April and the same decrease observed in consumption, this adjustment in companies' production plans occurred after the measures to reduce employment (Figures 3 and 4). This implies that the changes in the level of employment had contemporaneous effects on manufacturing production, not the other way around, but in subsequent periods.

The recursive relationships described above are expressed in a system of autoregressive vectors composed of an epidemiological variable and four economic variables of size M x 1 with $M = 5$, and whose vector of variables in first differences is described as $\Delta z'_t = [\Delta ERI_t \quad \Delta CMSD_t \quad \Delta EPM_t \, \Delta ETM_t \quad \Delta PM_t]'$, where Δ is the first differences operator. In this vector, the variable ERI is of epidemiological type and represents the virus infections at the national level that trigger respiratory problems potentially harmful to human health. Additionally, the variable $CMSD$ represents the level of consumption of goods produced by the manufacturing sector in the country. EPM and ETM express the level of national manufacturing employment in its permanent and temporary components, respectively; finally, the variable PM represents national manufacturing production. Subscript t follows the conventional notation to represent the time evolution of the variables. For its part, vector $\epsilon'_t = [\epsilon_t^{ERI} \quad \epsilon_t^{CMSD} \quad \epsilon_t^{EPM} \, \epsilon_t^{ETM} \quad \epsilon_t^{PM}]'$ with size M x 1 expresses the structural innovations that induce unexpected shocks to the epidemiological and economic variables. In its expanded form, the vector autoregression system is expressed in (1), where the elements in b_{MM} define the endogeneity of each variable:

$$\begin{bmatrix} 1 & b_{12} & b_{13} & b_{14} & b_{15} \\ b_{21} & 1 & b_{23} & b_{24} & b_{25} \\ b_{31} & b_{32} & 1 & b_{34} & b_{35} \\ b_{41} & b_{42} & b_{43} & 1 & b_{45} \\ b_{51} & b_{52} & b_{53} & b_{54} & 1 \end{bmatrix} \begin{bmatrix} \Delta ERI_t \\ \Delta CMSD_t \\ \Delta EPM_t \\ \Delta ETM_t \\ \Delta PM_t \end{bmatrix}$$
$$= \begin{bmatrix} \delta_{10} \\ \delta_{20} \\ \delta_{30} \\ \delta_{40} \\ \delta_{50} \end{bmatrix} + \begin{bmatrix} \sum_{j=1}^{p} \delta_{11j}{}^{i}L^{j} & \sum_{j=1}^{p} \delta_{12j}{}^{i}L^{j} & \sum_{j=1}^{p} \delta_{13j}{}^{i}L^{j} & \sum_{j=1}^{p} \delta_{14j}{}^{i}L^{j} & \sum_{j=1}^{p} \delta_{15j}{}^{i}L^{j} \\ \sum_{j=1}^{p} \delta_{21j}{}^{i}L^{j} & \sum_{j=1}^{p} \delta_{22j}{}^{i}L^{j} & \sum_{j=1}^{p} \delta_{23j}{}^{i}L^{j} & \sum_{j=1}^{p} \delta_{24j}{}^{i}L^{j} & \sum_{j=1}^{p} \delta_{25j}{}^{i}L^{j} \\ \sum_{j=1}^{p} \delta_{31j}{}^{i}L^{j} & \sum_{j=1}^{p} \delta_{32j}{}^{i}L^{j} & \sum_{j=1}^{p} \delta_{33j}{}^{i}L^{j} & \sum_{j=1}^{p} \delta_{34j}{}^{i}L^{j} & \sum_{j=1}^{p} \delta_{35j}{}^{i}L^{j} \\ \sum_{j=1}^{p} \delta_{41j}{}^{i}L^{j} & \sum_{j=1}^{p} \delta_{42j}{}^{i}L^{j} & \sum_{j=1}^{p} \delta_{43j}{}^{i}L^{j} & \sum_{j=1}^{p} \delta_{44j}{}^{i}L^{j} & \sum_{j=1}^{p} \delta_{45j}{}^{i}L^{j} \\ \sum_{j=1}^{p} \delta_{51j}{}^{i}L^{j} & \sum_{j=1}^{p} \delta_{52j}{}^{i}L^{j} & \sum_{j=1}^{p} \delta_{53j}{}^{i}L^{j} & \sum_{j=1}^{p} \delta_{54j}{}^{i}L^{j} & \sum_{j=1}^{p} \delta_{55j}{}^{i}L^{j} \end{bmatrix} \begin{bmatrix} \Delta ERI_t \\ \Delta CMSD_t \\ \Delta EPM_t \\ \Delta ETM_t \\ \Delta PM_t \end{bmatrix}$$
$$+ \begin{bmatrix} \epsilon_t^{ERI} \\ \epsilon_t^{CMSD} \\ \epsilon_t^{EPM} \\ \epsilon_t^{ETM} \\ \epsilon_t^{PM} \end{bmatrix} \tag{1}$$

The structural parameter matrix b_{MM} that defines the endogeneity of the epidemiological and economic variables is significant because it collects the restrictions required to identify and subsequently estimate the dynamic effects on these variables that result from inducing unexpected variations in vector ϵ'_t. The standard procedure to obtain these dynamic effects is to obtain the reduced and structural forms in their moving average representation. It was necessary to start from the compact form of Expression (1) to clarify this procedure, as follows:

$$\mathbf{B}\Delta\mathbf{z}_t = \sum_{j=1}^{p} \boldsymbol{\Gamma}_j L^j \Delta\mathbf{z}_t + \boldsymbol{\epsilon}_t \tag{2}$$

The reduced form of the vector autoregression system is then obtained by solving for Δz_t:

$$\Delta\mathbf{z}_t = \mathbf{B}^{-1} \sum_{j=1}^{p} \boldsymbol{\Gamma}_j L^j \Delta\mathbf{z}_t + \mathbf{B}^{-1}\boldsymbol{\epsilon}_t \tag{3}$$

Equivalently, Expression (3) can be rewritten as $R(L)\Delta z_t = u_t$, where u_t is the vector of shocks in reduced form, associated with the vector of structural shocks through the relation $u_t = B^{-1}\epsilon_t$, whose covariance matrix is positive and semi-defined and is given by $E[u_t u_t'] = B^{-1}E[\epsilon_t \epsilon_t']B^{-1\prime} = \Omega_u$. This covariance matrix is significant in the factorization process for identifying and estimating orthogonal shocks to the epidemiological and economic variables. The reduced-form moving average representation in Expression (4) picks up the dynamic effects as a linear combination of the structural shocks in $\mathrm{F(L)}$, which can be obtained directly by estimations:

$$\Delta z_t = F(L)u_t \tag{4}$$

The moving average representation in the structural form of the economic-epidemiological model expressed in (1) is obtained by substituting, in the above Expression, the relationship between shocks in reduced and structural form, $u_t = B^{-1}\epsilon_t$:

$$\Delta z_t = A(L)\epsilon_t \tag{5}$$

This structural version for the moving mean representation of the proposed VAR model is important for this research because it makes it possible to obtain the dynamic responses resulting from unexpected variations to the endogenous variables, $\mathrm{A(L)}$. Utilizing the variance decomposition of the forecast errors, it is possible to quantify the percentage partition of each shock and the counterfactual analysis. Matrix B^{-1} is of additional utility because it contains the loadings that help estimate the contribution of each structural shock in the vector of shocks in reduced form u_t, required in the development of the counterfactual analysis.

Model specification

The specification of the VAR model based on the recursive relationships described above is carried out by implementing an identification and subsequent estimation framework with short-term restrictions on the contemporaneous impact matrix $A(0)$ where $A(0) = B^{-1}$. This framework, which makes enables the recursive identification of both shocks and structural response functions, is expressed in (6), whose sequence of shocks conforms to the typical Choleski decomposition:

$$A(0)=\begin{bmatrix} a_{11} & 0 & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & a_{55} \end{bmatrix} \tag{6}$$

Specifically, this framework indicates that a surprise shock in the epidemiological variable, GERI, that induces an increase (or decrease) in infections by viruses that trigger respiratory problems would have a contemporaneous effect on the rest of the economic variables. This is plausible if considered from the point of view of the potential effects that health problems can have on the economy. This relationship is significant because it uncovers the direct effects of health problems on economic decisions, which are often neglected in the Mexican economic literature. Similarly, the rest of the economic variables would not have a contemporaneous direct effect on the epidemiological variable. However, it could occur in subsequent periods when, for example, an improvement in economic conditions may help to improve access to health services.

According to the sequence established for the rest of the economic variables, an unexpected variation in consumption would induce a contemporaneous effect on employment. However, the latter would only affect consumption after changes in the labor market. Similarly, manufacturing production can be influenced contemporaneously by changes in the consumption of manufacturing goods and employment. Nevertheless, changes in production would have an indirect or feedback effect on these variables in later periods. In this regard, it is important to point out that the established methodological strategy makes it possible to analyze the dynamic economic repercussions by considering the historical information of the recursive relationships indicated through, for example, the estimation of impulse-response functions. However, the analysis of the specific effect from the onset of the health containment measures is carried out through the counterfactual effect of unexpected variations in the variables.

Database, descriptive statistics, and stochastic behavior of the variables

The five endogenous variables are in monthly frequency and cover a period from January 2010 to May 2020. In the different cases, the variables were corrected for seasonality when necessary. Additionally, logarithmic transformations were performed before obtaining their first differences, as indicated in the vector $\Delta z'_t$.

The epidemiological variable representing virus infections that trigger respiratory problems with potential damage to health was approximated by the number of confirmed cases of pneumonia and was obtained from the epidemiological week records of the federal Secretariat of Health. The cases confirmed for COVID-19 by the federal Ministry of Health were added to the pneumonia cases. This strategy was used because particularly severe cases of COVID-19 ended up representing clinical pictures similar to pneumonia, according to recent national and international reports. The splicing of information made it possible to have a general variable that measures respiratory problems that can lead to serious or even fatal damage to health. It also helps to observe the behavior of a sudden outbreak of a disease whose high rate of contagion and lethality has the potential to induce sudden changes in the functioning of the Mexican manufacturing sector. The stable behavior of confirmed cases of pneumonia in the country offers a form of control to observe the occurrence of abrupt changes, as in the case of COVID-19. Table 1 presents some descriptive statistics of the endogenous variables. It indicates that the epidemiological variables and consumption of semi-durable goods display a greater fluctuation in their monthly growth rates around their average compared to the other variables. There is also a maximum value close to 300% in the epidemiological variable, attributed to the recent increase in COVID-19 cases, and contractions for the case of semi-durables consumption of 74%, permanent manufacturing employment of 1.7%, and production of 34%, registered in April 2020.

The consumption variable was measured using the semi-durable goods consumption index. At the same time, manufacturing production was obtained from the General Index of Economic Activity for the manufacturing sector. INEGI published both. The manufacturing sector's permanent and temporary employment variables were obtained from statistics available in the Mexican Social Security Institute's databases and, therefore, include only formal employment.

Table 1
Summary of descriptive statistics for monthly growth rate, 2010.1-2020.5

	GERI	GCMSD	GEPM	GETM	GPM
Average	6.8	0.1	0.3	0.6	0.1
Standard Dev.	40.6	11.5	0.6	2.0	5.7
Maximum	313.0	22.4	1.0	7.0	11.4
Minimum	-48.6	-75.5	-1.7	-5.8	-34.0

Source: created by the author with information from INEGI, IMSS, and the federal Secretariat of Health

Additionally, unit root tests were performed to identify the order of integration of the endogenous variables. The tests indicate that the variables are stationary in growth rates when considering one break using the method of Lee and Strazicich (2013). The only series that is stationary in growth rates when considering two breaks, according to Lee and Strazicich (2003), is the epidemiological variable (Table A1 in Annexes).

Quantifying the impact of the COVID-19 pandemic on the mexican manufacturing sector: Empirical evidence

The economic-epidemiological model of autoregressive vectors proposed in Expression (1) was estimated with information for the Mexican manufacturing sector. Two lags were used in the estimation, in

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accordance with the application of the Akaike (AIC), Bayesian (BIC), and Hannan-Quinn (HQ) information criteria, which consistently suggests this lag structure. The variance decomposition for each of the shocks in the model equations was calculated to check whether the endogenous variables included in the estimated autoregressive model would have economic significance in their contribution to the changes observed in the study period. Accordingly, the variation of the epidemiological variable (GERI) would be explained by the variations in consumption and permanent employment growth and, to a lesser extent, by the rest of the variables. As time passes, the contribution of both economic variables increases with respect to the same epidemiological variable (Table A2 in Annexes).

The variation in the growth of semi-durable goods consumption is due to variations in consumption and permanent manufacturing employment. Next, the epidemiological variable also seems to contribute an important result because it reflects the presence of possible direct effects on consumption decisions. The rest of the variables have a minor contribution consistent with the established effects sequence. Concerning the variable measuring growth in permanent employment, the variance decomposition indicates that its variation is self-explanatory, an aspect that reveals a strong endogenous adjustment mechanism in this type of employment (Table A3 in Annexes). Consumption growth, although with a smaller and decreasing contribution, is more significant than temporary employment in understanding changes in permanent employment. The decomposition contributes to changes in the epidemiological variable, although much smaller than consumption. The variance decomposition analysis for the model that endogenizes growth in temporary employment is consistent with the rest of the measurements, where its dynamics would explain its variation. However, it is noteworthy that permanent employment increases its contribution until it surpasses temporary employment itself, which indicates an important interaction between the two that should be considered in the analysis of labor markets (Table A3 in Annexes). Consumption and even the epidemiological variable, mainly the latter, have a smaller contribution. However, they suggest that they can induce adjustments in temporary employment and should also be considered in the analysis. Finally, concerning the manufacturing production variable, its variations would contribute to adjustments in the consumption of semi-durable goods and, secondarily, to changes in the growth of permanent manufacturing employment. The epidemiological variable would have some direct contribution, although minor. It was permitted to have a contemporaneous impact on the set of economic variables (Table A4 in Annexes).

Estimates of the responses were carried out for the growth rates and then accumulated to present the permanent effects on the endogenous variables. Figure 5 demonstrates that a shock that initially raises the number of confirmed cases of the infectious disease (GERI) by 1.5% fluctuates to increase again in the third month. However, it has a decreasing growth in the number of cases and begins to stabilize after the first year. This behavior reproduces a pattern of outbreaks for this type of disease, considering that

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information measuring pneumonia cases has been used, and only until the last few months were combined with confirmed cases of COVID-19[2]. The direct effect that an outbreak of this magnitude would have on the growth of economic variables suggests that the consumption of semi-durable goods (GCMSD) and manufacturing production (GPM) would be more negatively affected. In the first case, the consumption growth rate would decrease by approximately 0.5% in the first month. However, it would start to recover from the next month onwards, as the number of new infections is brought under control, and would begin to stabilize around the tenth month. The production growth rate would decrease by 0.15% in the first month, following a similar recovery pattern to consumption. In the case of employment, in its permanent (GEPM) and temporary (GETM) components, the direct effect on its growth seems to have been lower.

Concerning the growth rate response in the number of confirmed cases to variations in the economic variables, there are shocks in the growth of consumption and employment associated with a decrease in the growth of the epidemiological variable. This relationship does not imply an economic effect of cure or anything similar. Rather, access to greater economic well-being through consumption and employment, especially permanent employment, would provide the right economic conditions to protect oneself and recover from a potential infection with a respiratory disease. Changes in production do not have a significant direct effect but rather an indirect one through the employment variable (Figure 5). The dynamic response, followed by the economic variables concerning unexpected consumption ($\epsilon_t^{\mathrm{CMSD}}$), labor ($\epsilon_t^{\mathrm{EPM}}$ y $\epsilon_t^{\mathrm{ETM}}$), or production ($\epsilon_t^{\mathrm{PM}}$) shocks, adequately reproduce the behavior reported in empirical macroeconomic studies that include related variables, and by the economic theory itself, in such a way that makes it possible to validate the specification of the economic-epidemiological model explained in the methodological section. Accordingly, a shock that increases the growth rate of durable goods consumption by 1% in the first month would fluctuate to increase it again toward the third month, although to a lesser extent, and its initial impulse would fade toward the fifteenth month. On the other hand, an unexpected increase in employment that induces an increase of approximately 0.25% in the monthly growth rate of durable goods consumption would slowly fade even after two years. Specific increases in temporary employment and output would have positive but modest effects on monthly consumption growth (Figure 5)[3].

Furthermore, a shock that initially induces an increase in the growth of permanent manufacturing employment would be similar to the increase caused by an increase in the consumption of

[2]The records for confirmed cases of influenza A (H1N1) at the international level, which can also lead to pneumonia, indicate that the number of infections stabilized in the first year. The epidemiological variable studied here does not include the number of cases of this disease.

[3]Because impulse response functions are expressed in percentage ratios of change, i.e., elasticities, their magnitudes can be rescaled, for example, from 1% to 100%. However, a monthly growth rate is more likely to experience modest variations. For this reason, the impulse response analysis in Figures 5 and 6 is performed using the same percentage scaling.

durable goods. Although the effect would be more lasting in the first case, it is a result that underscores the importance of consumption in boosting employment. On the other hand, some features that stand out in relation to the functioning of the Mexican labor market consist of the interaction between permanent and temporary employment. In this case, an unexpected increase in the number of temporary workers in the manufacturing sector would have a small and lagged effect on the monthly growth rate of permanent employment. However, an increase in the growth rate of the number of permanent workers in manufacturing would have a greater contemporaneous effect on the monthly growth of temporary workers. This tends to be more long-lasting (Figure 1), an aspect predicted in the previous variance decomposition analysis. While replicating the fact that companies tend to establish the number of temporary workers once permanent contracts are established, these features also reflect the fact that the latter, although increasing less rapidly than temporary workers, still retain a higher proportion.

On the other hand, Figure 5 indicates that consumption is a significant component in the transmission channel of manufacturing economic activity. An unexpected increase in its monthly growth rate would induce effects that would increase production growth between 0.05% and 0.35% in the first ten months. This indicates that the implementation of economic measures that encourage consumption can function as significant stabilizing elements of the economic cycle fluctuations.

Figure 6 presents the permanent effects on the level of the economic and epidemiological variables derived from shocks to the respective growth rates. In this regard, the epidemiological shock would have a cumulative effect that would increase the number of confirmed cases of this disease (ERI) by about 6% about 30 months after the first outbreak, when it stabilizes around this figure. The permanent effect of consumption (CMSD) and permanent manufacturing employment (EPM) on the number of infections is significant, especially the latter, which would exceed the permanent effect of temporary employment in this sector (ETM). The permanent direct effect of the increase in the number of confirmed cases on the manufacturing sector's performance suggests a contraction in the medium term of 3% in the consumption of semi-durable goods and approximately 1% in the case of manufacturing production. It is worth noting that the cumulative effect of the increase in the growth of permanent employment would be approximately 6% for the consumption of semi-durable goods in the following two and a half years, giving it greater significance in relation to temporary employment, whose effect would be close to 2%.

Due to the structure of the Mexican labor market, the impulse-response functions indicate a complementary type of interaction between the aggregate components of permanent and temporary employment in the medium term. However, the permanent effect of the latter on the former is only 0.1% in the medium term, while the reverse effect is 0.3%. This 3 to 1 ratio in the response elasticities in the medium term suggests that permanent employment would be conditioning the creation of new temporary jobs (Figure 6).

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The initial boost to the growth rate of consumption of semi-durable goods would lead to an approximate 1% increase in manufacturing output in the medium term. In comparison, permanent employment would have an effect of close to 1.5% in the same period. Together, both employment components would induce a permanent effect of 2.2% on manufacturing output (Figure 6). This behavior suggests, once again, that stimulus to consumption, in this case of semi-durable goods and to employment itself, can help counteract contractions in general economic activity.

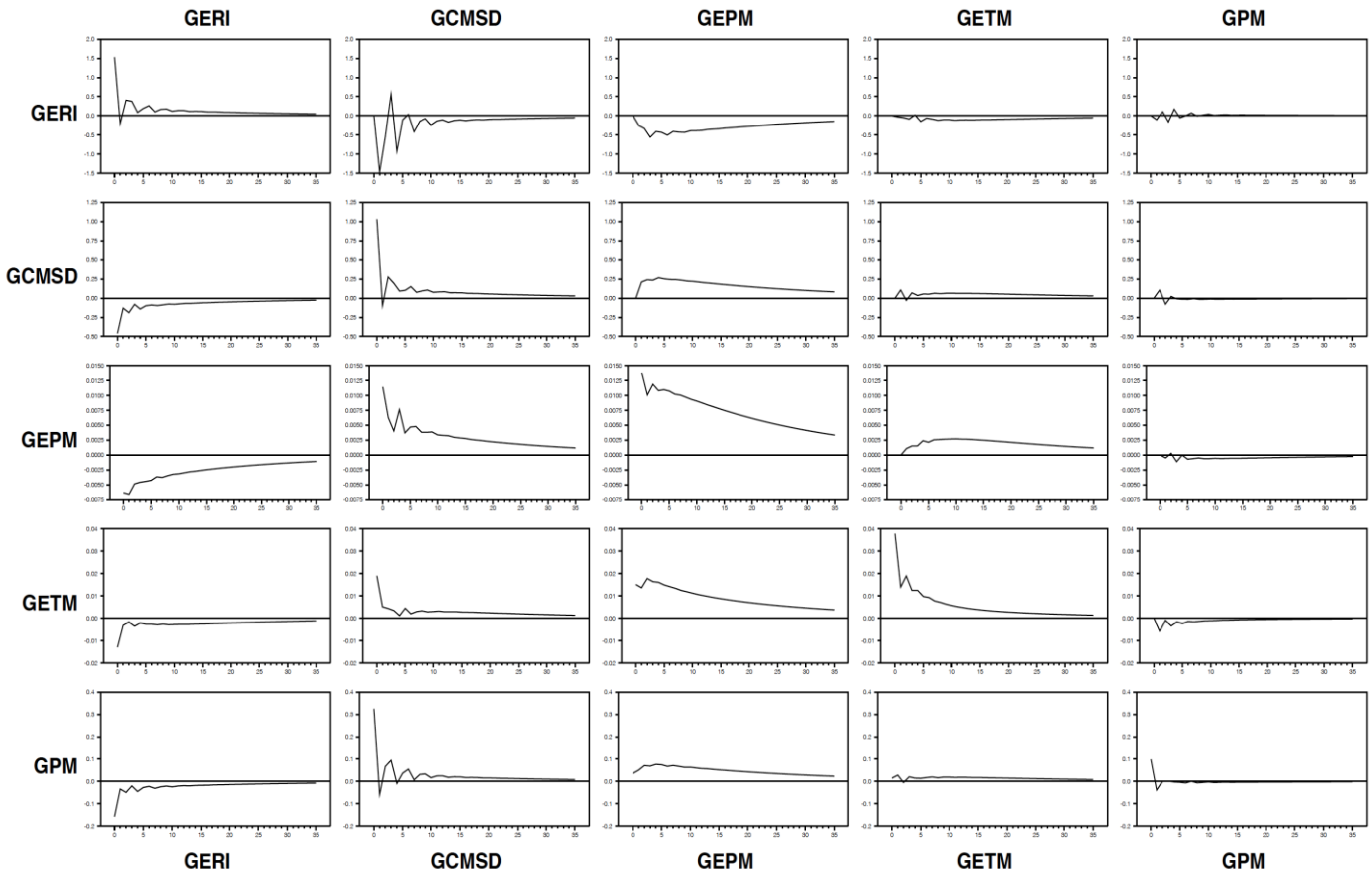

Figure 5. Growth rate responses of endogenous variables
Source: created by the author

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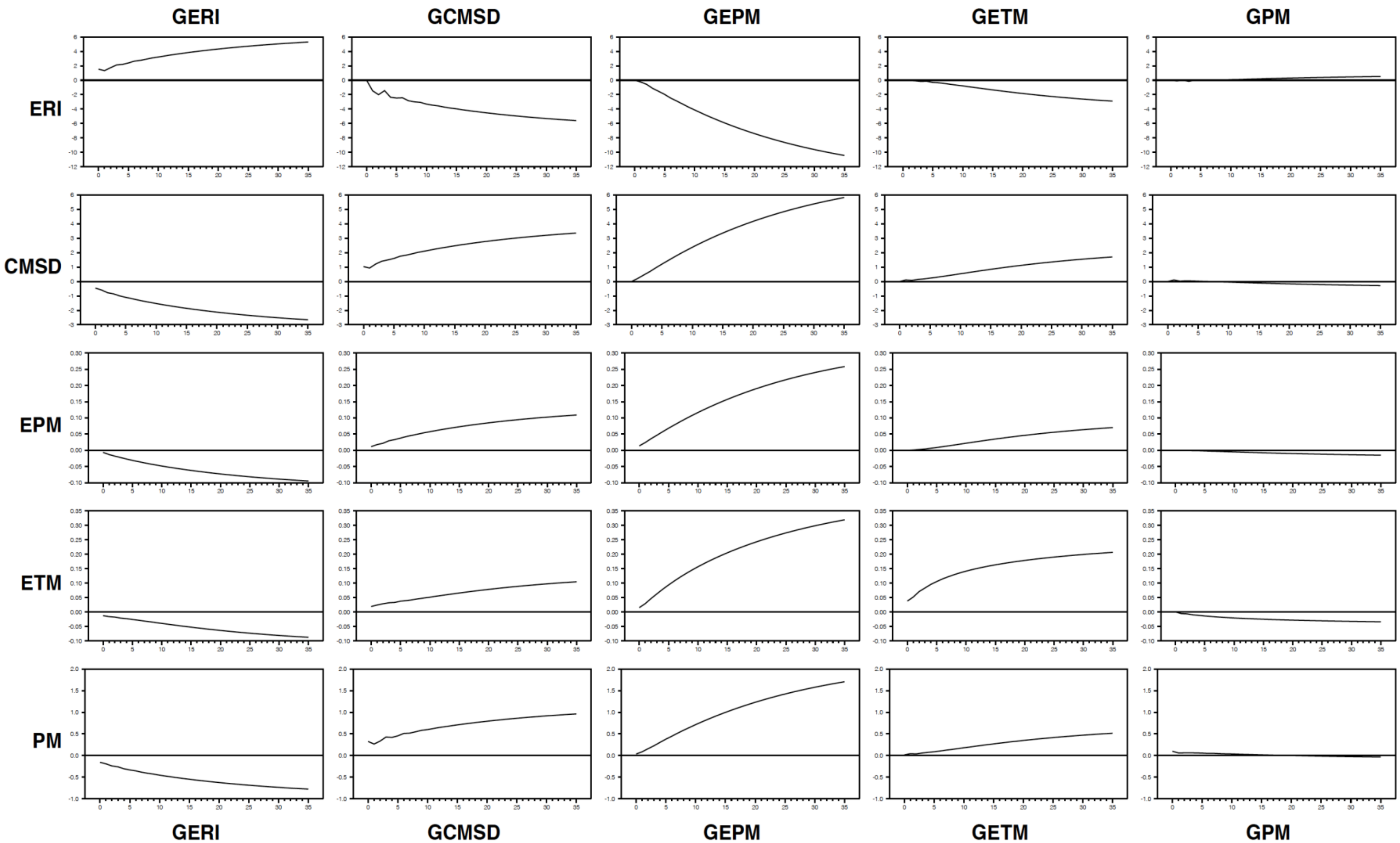

Figure 6. Responses of the endogenous variables in levels
Source: created by the author

The economic effect of health contingency measures and consumption incentives: A counterfactual analysis

The previous subsection analyzed the transitory and permanent economic effects of different types of economic shocks, including an epidemiological shock, considering the history described in the statistical information used. This subsection, on the other hand, analyzes the economic effect of the health contingency measures implemented and of some economic measures based on consumption stimulus, starting from the month in which these measures were implemented, i.e., since March 2020. The study takes advantage of the methodology employed in the previous subsection to perform three types of counterfactual analysis: 1) Supposing that there had been no epidemiological outbreak of COVID-19, to measure the impact derived from the contingency measures; 2) Supposing the absence of the contractionary effects on consumption; 3) Supposing a stimulus to consumption equivalent in size to its contraction in April 2020.

Concerning the first type of analysis, the study extracted the contribution of the structural shock component associated with the effect of the COVID-19 outbreak between March and May; with this strategy, it was possible to discount the direct epidemiological effect and quantify only the result of the economic shocks. Figure 7 indicates that the counterfactual contraction in semi-durable goods consumption (CONTRAGCMSD) is smaller than the contraction observed during April and May, attributing a considerable epidemiological direct effect of close to 22% in April. The gap between CONTRAGCMSD and GCMSD decreased toward May when contingency measures and economic shocks contributed significantly less to the contraction in consumption. Additionally, panel B indicates that the reduction in permanent manufacturing employment would be smaller without the COVID-19 outbreak. However, the gap between the two widens, indicating that the contribution of the direct epidemiological effect increases from 22% to 32%, although without taking precedence over contingency measures and economic shocks. This feature of the counterfactual analysis is preserved for reducing temporary employment in the same months. However, the effects of contingency measures and economic shocks still account for 78% and 75% in April and May. Regarding the growth of manufacturing activity, in the absence of the direct effects of COVID-19, its contraction would be lower. It would even rebound positively toward May due to the economic shocks and the containment measures that had made possible the reopening of some economic activities by then.

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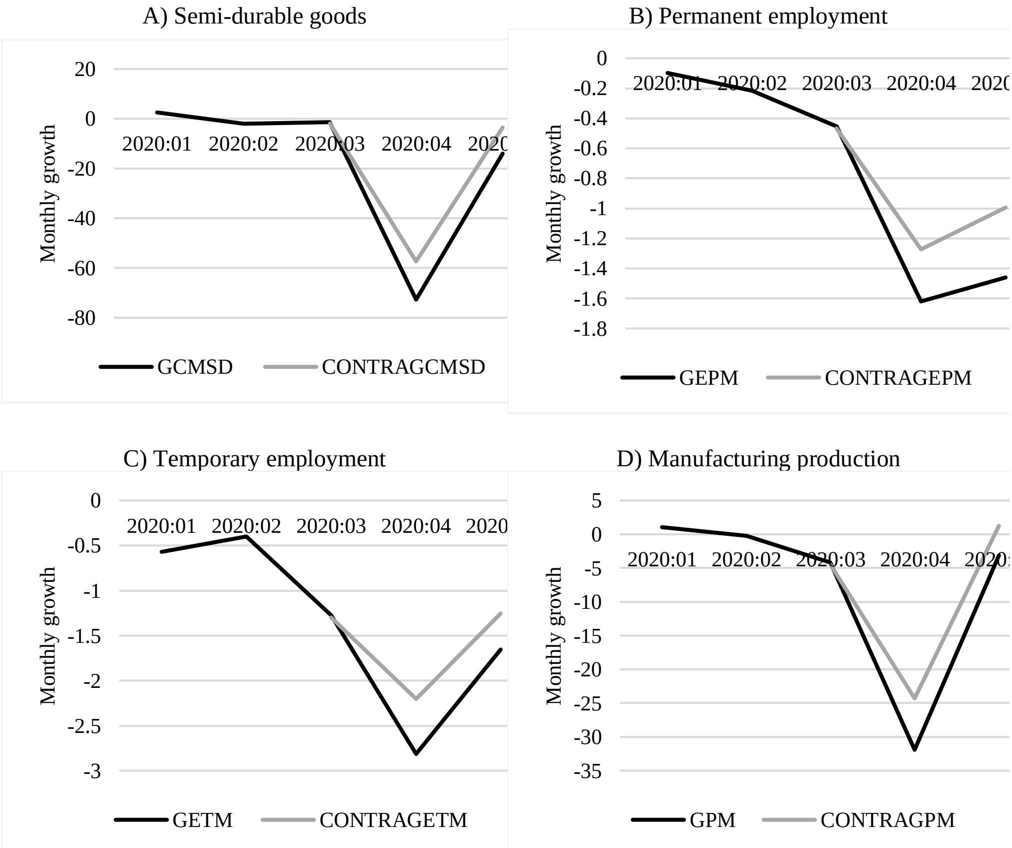

Figure 7. Counterfactual analysis for growth rate in the absence of the COVID-19 outbreak in Mexico
Source: created by the author

When the effect of direct shocks on the consumption of semi-durable goods is extracted, the counterfactual analysis makes it possible to establish their contribution to the manufacturing sector's performance from March through May. The results in Figure 8 indicate that the joint contraction in the economic variables would have been smaller, during these three months, compared to the contraction when the absence of the COVID-19 outbreak was considered in Figure 7. The cumulative contractionary effect on consumption, approximately 35%, is less than that attributed to the direct epidemiological effect on this same variable of 28% in Figure 7. Similarly, the cumulative effect of the fall in production is close to 24%, confirming the importance of consumption in the transmission channel during the critical months for manufacturing economic activity.

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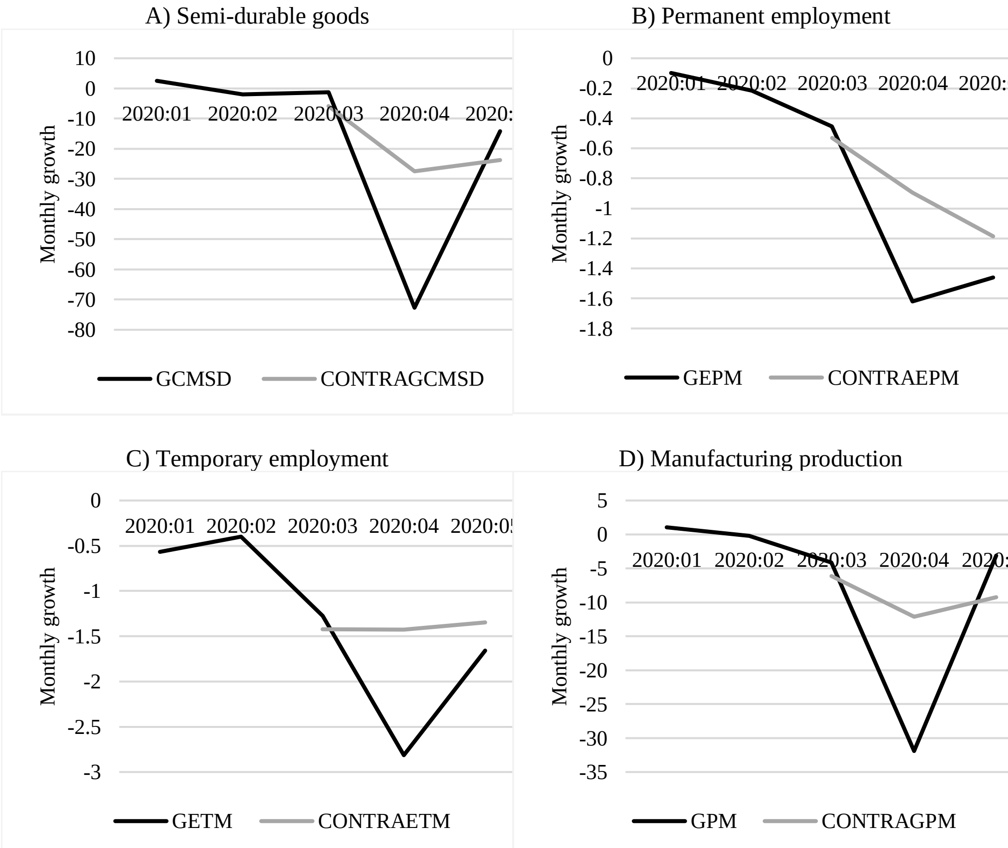

Figure 8. Counterfactual analysis for the growth rate in the absence of the consumption effect in Mexico
Source: created by the author

While contingency measures focus directly on controlling the increase in the number of infections, their aim may be more complicated to achieve than, for example, influencing economic behavior. The above results indicate that a consumption stimulus can help counteract the contractionary economic effects of contingency measures and the sequential effects derived from the associated economic decisions of consumption, employment, and manufacturing production. This is because consumption represents an initial triggering component in the transmission channel during this type of economic contraction. Figure 9 indicates that a stimulus to consumption of a similar magnitude to its contraction in April would have countercyclical effects on the growth of the economic variables studied. A stimulus of this size would help to achieve an overall contraction of 46% in the set of economic variables from March to May, much less than the 91% contraction in the analysis of Figure 8. While the consumption stimulus alone would help a faster economic recovery, it would have to be coupled with appropriate health measures to achieve safe consumption.

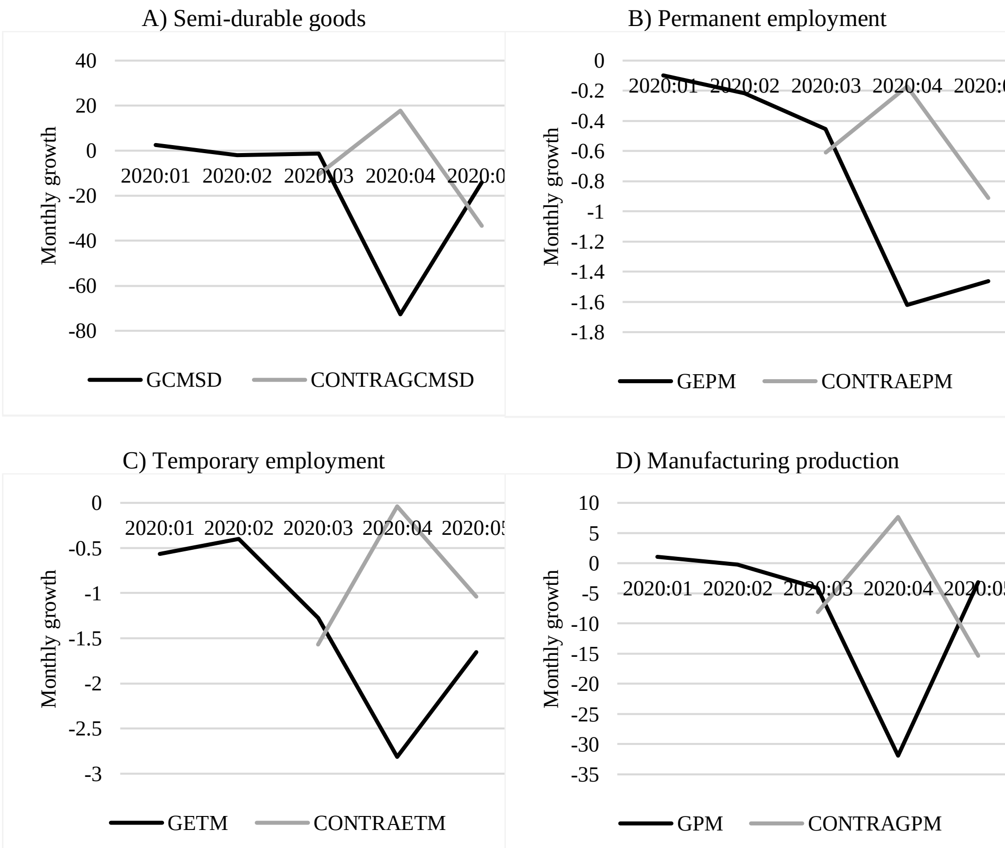

Figure 9. Counterfactual analysis for the growth rate with a stimulus to consumption equivalent to its contraction
Source: created by the author

Conclusions

This research analyzed the repercussions that sanitary contingency measures to limit the number of COVID-19 infections could have on the performance of the Mexican manufacturing sector. The analysis is carried out by implementing a vector autoregression economic-epidemiological model, whose specification is based on the sequence observed in the interaction between the variables of consumption of semi-durable goods, permanent and temporary employment in the manufacturing sector, and production in this sector in recent months.

The impulse response functions reproduce the expected dynamic effects on the endogenous economic variables: an increase in the growth of consumption, employment, and production, due to positive shocks that stimulate these same variables, suggests that the model is properly specified. A significant and novel result is the consistently contractionary effect on the monthly growth of economic variables due to surprising increases in cases of infectious diseases, with potentially harmful and even fatal consequences for human health.

The counterfactual analysis, which makes it possible to focus the study of the repercussions in the period when the pandemic begins, indicates that the contingency measures, together with the economic effects derived from the decisions of the economic agents, had a minor impact on the contractions observed toward May, due to the reopening process synchronized with the continuation of the health prevention measures. In particular, changes in consumption played a key role in the contractions observed in employment and production, not only because of the magnitude of their contribution but because of their position as a trigger in the transmission channel studied. The counterfactual analysis suggests that economic measures that stimulate consumption would have countercyclical effects that would help to diminish the negative effect on the performance of the manufacturing sector and favor conditions for a faster economic recovery. On the other hand, although the analysis focuses on the effects of measures on consumption, it is expected that a combination of measures focused on stimulating employment could reinforce the countercyclical effects indicated.

The warnings of the World Health Organization regarding the importance of moving from a situation of an apparent trade-off between the preservation of human health and the proper functioning of the economy during the first months of the pandemic (WHO, 2020) to a situation of complementarity between both aspects requires moving from the general plans for resuming economic activities that currently prevail, to plans with specific health prevention measures for different economic activities. A complementary measure would seek to encourage, through new fiscal incentives, the transition toward the implementation of measures and protocols for safe consumption.

Thus, not only will the economic management of this pandemic, and of those to come, have to take into account the possible disappearance of economic activities and the replacement of jobs by those with a greater component of information technologies (Cajner et al., 2020), but companies will also have to increasingly compete by differentiating their products and services through the implementation of measures and protocols that help to protect human health.

Finally, due to the importance of establishing the effects that this type of health crisis has on the functioning of national economies and identifying the specific economic and sanitary measures required to cushion its negative effects and achieve economic recovery, the study of the economics of the pandemic for the Mexican case can be extended to other economic sectors that have also been severely affected. It could also incorporate the analysis of the repercussions for regional economies. Furthermore, a promising line of research would be to investigate further the mechanisms, effects, and asymmetries between, for example, the contraction of the Mexican economy of external origin between 2008 and 2009 and that caused by the COVID-19 pandemic.

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Annex

Table A1
Unit root tests for the endogenous variables

	DFA t-statistic	Critical values 1%	5%	LS 1 break t-statistic	Critical values 1%	5%
ERI	0.43	-3.48	-2.88	-5.72	-4.54	-3.99
GERI	0.86	-3.48	-2.88	-8.17	-4.54	-3.99
CMSD	-1.15	-3.48	-2.88	-1.71	-4.00	-3.40
GCMSD	-10.75	-3.48	-2.88	-11.60	-4.00	-3.40
EMP	-1.39	-3.48	-2.88	-1.52	-4.54	-3.99
GEMP	1.34	-3.48	-2.88	-6.88	-4.54	-3.99
ETM	-2.16	-3.48	-2.88	-1.13	-4.70	-4.15
GETM	-0.99	-3.48	-2.88	-7.70	-4.55	-4.00
PM	-1.42	-3.48	-2.88	-1.75	-4.00	-3.40
GPM	-1.20	-3.48	-2.88	-12.21	-4.00	-3.40

Source: created by the author; Note: The t-statistic calculated for the ERI variable (GERI) with 2 breaks is -5.73 (-8.49), and its critical values at 1% and 5% are -6.18 and -5.50 (-6.17 and -5.50), respectively.

Table A2
Variance decomposition for the growth in infectious respiratory diseases (GERI) and growth in consumption of semi-durable goods (GCMSD) variables

GERI						GCMSD					
Period	GERI	GCMSD	GEPM	GETM	GPM	Period	GERI	GCMSD	GEPM	GETM	GPM
1	100.00	0.00	0.00	0.00	0.00	1	16.55	83.45	0.00	0.00	0.00
2	51.74	46.67	1.34	0.02	0.24	2	16.66	78.47	3.26	0.83	0.79
3	49.14	47.09	3.28	0.07	0.43	3	17.05	74.45	6.62	0.79	1.10
4	44.92	46.07	8.01	0.19	0.81	4	16.36	72.01	9.55	1.02	1.06
5	38.29	51.27	9.16	0.17	1.11	5	16.56	68.33	13.09	1.03	1.00
6	37.44	49.61	11.38	0.47	1.11	6	16.30	65.66	15.94	1.14	0.96
7	36.73	47.49	14.21	0.51	1.06	7	15.92	63.67	18.26	1.23	0.93
8	35.21	47.50	15.63	0.58	1.08	8	15.76	61.48	20.49	1.38	0.90
9	34.51	46.35	17.35	0.74	1.05	9	15.55	59.67	22.41	1.49	0.87
10	33.93	45.14	19.05	0.85	1.02	10	15.31	58.21	23.99	1.63	0.86
11	33.17	44.60	20.26	0.95	1.02	11	15.15	56.78	25.47	1.77	0.84
12	32.64	43.81	21.47	1.09	1.00	12	14.98	55.55	26.75	1.89	0.82
13	32.18	43.04	22.60	1.20	0.98	13	14.81	54.50	27.86	2.02	0.81
14	31.70	42.51	23.52	1.31	0.97	14	14.68	53.52	28.87	2.14	0.80
15	31.30	41.95	24.38	1.42	0.96	15	14.55	52.65	29.76	2.25	0.79
16	30.95	41.42	25.17	1.51	0.95	16	14.43	51.89	30.55	2.35	0.78
17	30.61	40.99	25.86	1.61	0.94	17	14.33	51.19	31.26	2.44	0.78
18	30.31	40.58	26.48	1.69	0.93	18	14.23	50.57	31.90	2.53	0.77
19	30.05	40.20	27.05	1.77	0.93	19	14.14	50.01	32.47	2.61	0.76
20	29.80	39.88	27.56	1.84	0.92	20	14.06	49.51	32.98	2.69	0.76
21	29.58	39.57	28.02	1.91	0.91	21	13.99	49.05	33.45	2.76	0.76
22	29.38	39.30	28.44	1.98	0.91	22	13.93	48.64	33.86	2.82	0.75
23	29.20	39.05	28.82	2.03	0.91	23	13.87	48.27	34.24	2.88	0.75
24	29.03	38.82	29.16	2.09	0.90	24	13.81	47.93	34.59	2.93	0.74
25	28.88	38.61	29.48	2.13	0.90	25	13.76	47.62	34.90	2.98	0.74
26	28.74	38.42	29.76	2.18	0.89	26	13.72	47.34	35.18	3.02	0.74
27	28.62	38.25	30.02	2.22	0.89	27	13.68	47.09	35.44	3.07	0.74
28	28.50	38.09	30.26	2.26	0.89	28	13.64	46.85	35.67	3.10	0.73
29	28.40	37.95	30.48	2.29	0.89	29	13.60	46.64	35.89	3.14	0.73
30	28.30	37.82	30.67	2.32	0.88	30	13.57	46.45	36.08	3.17	0.73

Source: created by the author

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Table A3
Variance decomposition for the variables of growth in permanent manufacturing employment (GEPM) and growth in contingent manufacturing employment (GETM)

Variance decomposition for GEPM						Variance decomposition for GETM					
Step	GERI	GCMSD	GEPM	GETM	GPM	Step	GERI	GCMSD	GEPM	GETM	GPM
1	11.11	36.17	52.72	0.00	0.00	1	7.70	16.48	10.39	65.43	0.00
2	15.26	31.09	53.39	0.21	0.04	2	6.76	14.66	15.66	61.70	1.24
3	14.65	25.52	59.31	0.47	0.04	3	5.43	12.15	21.86	59.55	1.00
4	13.75	26.30	59.16	0.63	0.17	4	5.10	10.99	26.28	56.44	1.19
5	13.54	23.71	61.55	1.06	0.14	5	4.69	9.92	29.77	54.49	1.13
6	13.26	22.43	62.86	1.29	0.16	6	4.48	9.59	32.35	52.41	1.17
7	12.82	21.70	63.69	1.63	0.17	7	4.35	9.08	34.46	50.97	1.14
8	12.60	20.72	64.59	1.93	0.17	8	4.29	8.79	36.22	49.57	1.13
9	12.35	20.00	65.27	2.20	0.18	9	4.23	8.62	37.60	48.43	1.12
10	12.11	19.50	65.75	2.46	0.19	10	4.23	8.46	38.80	47.41	1.11
11	11.92	18.96	66.22	2.71	0.19	11	4.23	8.35	39.81	46.52	1.10
12	11.75	18.52	66.60	2.92	0.20	12	4.24	8.29	40.66	45.73	1.09
13	11.59	18.18	66.90	3.13	0.20	13	4.26	8.23	41.41	45.03	1.07
14	11.46	17.84	67.18	3.31	0.21	14	4.29	8.19	42.06	44.40	1.06
15	11.34	17.56	67.41	3.48	0.21	15	4.31	8.18	42.63	43.84	1.06
16	11.23	17.32	67.61	3.63	0.22	16	4.34	8.16	43.13	43.33	1.05
17	11.13	17.10	67.79	3.76	0.22	17	4.37	8.15	43.57	42.88	1.04
18	11.05	16.90	67.94	3.89	0.23	18	4.39	8.14	43.97	42.47	1.03
19	10.97	16.73	68.07	4.00	0.23	19	4.42	8.14	44.32	42.10	1.03
20	10.90	16.58	68.19	4.10	0.23	20	4.44	8.14	44.64	41.77	1.02
21	10.84	16.44	68.30	4.19	0.24	21	4.46	8.14	44.92	41.46	1.01
22	10.78	16.32	68.39	4.27	0.24	22	4.49	8.15	45.17	41.19	1.01
23	10.73	16.21	68.47	4.35	0.24	23	4.51	8.15	45.41	40.94	1.00
24	10.69	16.11	68.55	4.42	0.24	24	4.52	8.15	45.61	40.71	1.00
25	10.65	16.02	68.62	4.48	0.25	25	4.54	8.16	45.80	40.50	1.00
26	10.61	15.94	68.68	4.53	0.25	26	4.56	8.16	45.97	40.32	0.99
27	10.57	15.87	68.73	4.58	0.25	27	4.57	8.16	46.13	40.14	0.99
28	10.54	15.80	68.78	4.63	0.25	28	4.59	8.17	46.27	39.99	0.99
29	10.52	15.74	68.82	4.67	0.25	29	4.60	8.17	46.40	39.84	0.98
30	10.49	15.69	68.86	4.71	0.25	30	4.61	8.18	46.52	39.71	0.98

Source: created by the author

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Table A4
Variance decomposition for manufacturing production growth (GPM) variables

Variance decomposition for GPM					
Step	GERI	GCMSD	GEPM	GETM	GPM
1	17.48	74.51	0.93	0.16	6.92
2	17.13	72.14	2.59	0.68	7.46
3	17.33	69.59	5.53	0.64	6.91
4	16.13	68.94	7.76	0.83	6.35
5	16.50	65.93	10.60	0.91	6.07
6	16.20	63.93	13.08	0.97	5.83
7	15.76	62.75	14.81	1.08	5.60
8	15.71	60.81	16.81	1.24	5.43
9	15.50	59.44	18.45	1.32	5.28
10	15.27	58.34	19.78	1.46	5.15
11	15.17	57.09	21.12	1.58	5.03
12	15.02	56.11	22.25	1.69	4.93
13	14.87	55.26	23.23	1.80	4.84
14	14.77	54.41	24.16	1.91	4.76
15	14.66	53.69	24.97	2.00	4.69
16	14.55	53.05	25.68	2.09	4.62
17	14.47	52.45	26.34	2.18	4.56
18	14.39	51.92	26.93	2.25	4.51
19	14.31	51.44	27.46	2.33	4.46
20	14.24	51.00	27.94	2.39	4.42
21	14.18	50.61	28.37	2.45	4.38
22	14.12	50.25	28.77	2.51	4.35
23	14.07	49.93	29.13	2.56	4.32
24	14.02	49.63	29.45	2.61	4.29
25	13.98	49.36	29.75	2.65	4.26
26	13.94	49.12	30.01	2.69	4.24
27	13.91	48.89	30.26	2.73	4.22
28	13.87	48.69	30.48	2.76	4.20
29	13.84	48.50	30.69	2.79	4.18
30	13.82	48.33	30.88	2.82	4.16

Source: created by the author