ISSN 2448-8402

# ENSAYOS
## Revista de Economía

Volumen XXXV, número 2 noviembre de 2016

## Artículos



UANL
UNIVERSIDAD AUTÓNOMA DE NUEVO LEÓN

Universidad Autónoma de Nuevo León
Facultad de Economía
Centro de Investigaciones Económicas

Ensayos Revista de Economía, Vol. 35, No. 2, julio-diciembre 2016. Es una publicación semestral, editada por la Universidad Autónoma de Nuevo León, a través de la Facultad de Economía con la colaboración del Centro de Investigaciones Económicas. Domicilio de la publicación: Av. Lázaro Cárdenas 4600 Ote., Fracc. Residencial Las Torres, Monterrey, N.L. C.P. 64930. Tel. +52 (81) 8329 4150 Ext. 2463 Fax. +52 (81) 8342 2897. Editor Responsable: Jorge Omar Moreno Treviño. Reserva de derechos al uso exclusivo No. 04-2009-061215024200-102, ISSN 1870-221X, ambos otorgados por el Instituto Nacional del Derecho de Autor. Licitud de Título y Contenido No. 14910, otorgado por la Comisión Calificadora de Publicaciones y Revistas Ilustradas de la Secretaría de Gobernación. Registro de marca ante el Instituto Mexicano de la Propiedad Industrial: 1182771. Impresa por: Serna Impresos, S.A. de C.V., Vallarta 345 Sur, Centro, C.P. 64000, Monterrey, Nuevo León, México. Fecha de terminación de impresión: 1 de noviembre de 2016. Tiraje: 30 ejemplares. Distribuido por: Universidad Autónoma de Nuevo León, a través de la Facultad de Economía, Av. Lázaro Cárdenas 4600 Ote., Fracc. Residencial Las Torres, Monterrey, N.L. C.P. 64930.

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# Do Technology-Intensive Activities Drive Industrial Labor Productivity Levels?

## *¿Las actividades tecnológicamente intensivas impulsan la productividad laboral industrial?*

Raúl Vázquez López*

Fecha de recepción: 11 IV 2016 Fecha de aceptación: 22 IX 2016

**Abstract**

This article analyzes the contribution of technology-intensive activities to the increase in aggregate labor productivity in the industrial sector for a set of 28 countries, dividing 150 industrial classes into four groups based on their degree of technology content (High, Medium-High, Medium-Low and Low). After decomposing the evolution of labor productivity with a statistical method, it was found that these activities did not contribute significantly to the increase in the efficiency indicator. These exercises also corroborate the absence of a global structural change in industry that would drive levels of aggregate labor productivity.

***JEL Classification*:** L16; O14; L60.
***Keywords*:** Industry. Structural Change. Productivity. Technology Change. Economic Development.

**Resumen**

El presente artículo analiza, para 28 países, la contribución de las actividades tecnológicamente intensivas al incremento de la productividad laboral agregada del sector industrial, separando 150 clases industriales en cuatro grupos en función de su contenido en tecnología (Alta, Media Alta, Media Baja y Baja). Tras aplicar una técnica estadística de descomposición de la evolución de la productividad laboral, se encuentra que no existe un aporte significativo de estas actividades al aumento del indicador de eficiencia. Los

* Institute of Economic Research (IIEc.)-National Autonomous University of Mexico (UNAM). Address: Circuito Mario de la Cueva s/n, Ciudad Universitaria, Coyoacán, CP 04510, Mexico City. Email: ravazz@hotmail.com

The research was supported by the UNAM-DGAPA-PAPIIT Program IN302815.

ejercicios efectuados permiten también corroborar la ausencia de un cambio estructural global en la industria propulsor de los niveles de productividad laboral agregados.

***Clasificación JEL*:** L16; O14; L60.
***Palabras Clave*:** Industria. Cambio estructural. Productividad. Cambio tecnológico. Desarrollo Económico.

## Introduction

Historically, ample literature has maintained the need for a structural change to revitalize productivity levels as a prerequisite for economic growth and development. Both the orthodox perspective and various heterodox approaches have promoted the practicality of directing available resources towards more efficient uses through transformations in the sectoral composition of the economy. From one point of view, neoclassical axioms defend the capacity of the market to efficiently allocate resources to different uses and understand global economic liberalization as an opportunity to relocate productive factors and inputs to more profitable uses (Bhagwati, 1988).

Grossman and Helpman (1991) specifically emphasize the relevance of innovation, the deliberate result of investment in industrial research and development, as a growth factor, and ascertain that countries specialized in high-technology activities achieve higher productivity growth rates. Lucas (1988) goes even further in this argument, suggesting that public policy measures are essential in fostering structural changes to transform the productive specialization pattern in favor of technology-intensive sectors with better expectations for the terms of international exchange.

Likewise, the structuralist approaches, such as the Economic Commission for Latin America and the Caribbean (ECLAC) point of view, underline the importance of generating spillover effects, pecuniary and technological externalities and backward and forward linkages resulting from the structural change (Cimoli, 2005A). In the tradition of structural change models with an unlimited supply of labor, such as models by Lewis (1955), Jorgenson (1961) and Fei and Ranis (1961), Furtado (1963), also related to this school of thought, professes the need to transfer workers from more backward sectors, such as agriculture, to modern sectors (read: industry), as a first step to invigorate demand. This line of argument incorporates Keynesian principles, because the increase in productivity resulting from the change in employment composition leads to wage raises that diversify consumption and in turn transform the productive structure to become more efficient.

At the level of the industrial sector, a version of these reflections is related to the proposal to scale the productive specialization pattern towards activities with higher technology content, which would imply developing new industries with the consequent transfer of workers and capital to these industries. The basis for this type of analysis is varied, but in works by Hoffmann (1958) and Chenery, Robinson and Syrquin (1986), this process consists of the displacement of light industries by heavy industries that are more technology-intensive and have higher labor productivity. The categories in articles by Chenery and Taylor (1968) and Syrquin (1988) are divided into early, middle and late industries, the latter of which are the most sophisticated and efficient. As Timmer and Szirmai (2000) summarized, this evolution is related to technological upgrading that produces a bonus for overall industrial labor productivity growth, as more advanced activities have a greater capacity to accumulate capital than traditional activities.

More recently, in the Nelson and Pack (1999) model, the aggregate increase in productivity was also driven by a structural change consisting of the expansion of the modern sector using more efficient technologies and with higher profits, as compared to traditional activities. It is worth noticing, however, that in this evolutionary perspective, the existence of a superior technology does not automatically imply that it spreads to the rest of the structure (David, 1985; Arthur, 1989). Neo-Schumpeterian principles also maintain that the introduction of a new technology paradigm (Dosi, 1982) causes leadership in productive development to shift from industries tied to older technologies towards more dynamic industries that exploit the new paradigm, which stimulates overall economic growth.

Silva and Teixeira (2011) reached a similar conclusion by demonstrating the association between successful experiences of rapid growth and structural change in 21 countries (20 OECD countries plus Taiwan) in the time period 1979-2003, calculating the Nickell and Lilien indices, based on data from the Groningen Growth and Development Center Industry Database, among other sources, for 56 branches under ISIC (International Standard Industrial Classification) Rev. 3. After estimating regressions using the panel data methodology, these authors found that countries with the fastest structural change benefited the most from a greater increase in the relative weight of human capital-intensive and innovation-intensive industries. Their results also indicated that these knowledge-based industries had a positive and significant impact on the increase in aggregate productivity, concluding that sectors associated with the production (but not consumption) of information and communication technologies are strategic for economic growth.

In the SES (Schumpeterian, evolutionary and structuralist) synthesis currently promoted by ECLAC, in the context of the growth or creation of

specific new activities, innovation leads structural change, thereby giving rise to a virtuous growth cycle. From that perspective, the characteristics of knowledge intensive activities, their dynamism in international markets and the potential to increase productivity levels are the criteria to identify sectors that foster structural change (Peres and Primi, 2009). Rising employment and labor productivity are intimately tied to economic diversification, especially to the greater weight of high-technology activities in the manufacturing structure (Cimoli and Porcile, 2009). In fact, these authors measured structural change as the variation of the share of sectors involved in the "diffusion of knowledge" in the total value added of manufacturing and maintain that structural articulation, both at the micro and mesoeconomic level, is produced through the absorption of products and the improvement of productive processes with higher technology content (Cimoli, Porcile, Primi and Vergara, 2005).

In this regard, the work compiled by Cimoli (2005B) draws on various studies to relate the persistence of within and between-sector industrial structural heterogeinity, and the low articulation of export activities with the rest of the productive system, with the absence of structural change processes that would bolster technology use in Latin America. Cimoli *et al.* (2005) calculated the variation of the participation of various knowledge-diffusing sectors in the total aggregate manufacturing value for the period 1970-2000 in a group of 17 economies (seven in Latin America), using information from the ECLAC PADI database and the OECD Industrial Structural Analysis database. Their results indicate that the increase in this participation was hardly significant, rising from 21.2% to 28.3% for Latin American countries on average, while the coefficient fell for Argentina, Colombia, Peru and Uruguay. Broadly speaking, these authors document the absence of structural change in favor of these knowledge-diffusing sectors in the manufacturing apparatus in the region and the widening of the technology gap with respect to the United States and other emerging Asian economies, such as Korea, Malaysia, Singapore and Taiwan.

Based on a correlation matrix in which technology variables had relatively low coefficients with growth as compared to structural change, it is suggested that these variables act indirectly by transforming the productive structure. The article then cites findings from Holland and Porcile (2005), who used a shift-share technique and calculated the null contribution of structural change, referring to the transfer of employment towards more productive purposes (static effect) or increasingly productive purposes (dynamic effect) to the evolution of the industrial labor indicator in Argentina, Brazil, Chile, Colombia, Mexico and Uruguay between 1970 and 2002, looking at data for 28 sectors. In fact, in this Latin American study, the total increase in labor productivity for the unweighted average of the six countries had a negative

relationship (-0.5%) with the rate of industrial employment increase, while the efficiency indicator fell due to the dynamic transfer effect, from 0.6% in the 1970s to -4.7% in the 1990s.

Along this line of thinking, Ocampo's vision (Ocampo, 2005 & 2011) seeks to integrate structuralist analysis with reflections on technological upgrading, in a balanced fashion. After indicating that various productive branches have different capacities to increase productivity, the author proposes the existence of two essential phenomena in productive development: "innovation" and "complementarities"[1]. The main externalities arise from their interaction. Despite maintaining the idea that an export pattern based on technology content is central, in keeping with other authors in this ECLAC school of thought, the author significantly recognizes that 'when value chains disintegrate, the link between the technological content of export products and production activities may be broken, especially in the case of *maquila*. In these cases, and in export industries that use large volumes of imported inputs, the complementarities may also be very limited' Ocampo (2011).

In this regard, the elevated participation of sectors classified as high-technology in the total added value of industry alone and without the consequent development of the necessary complementarities may not contribute to a structural change that would drive aggregate efficiency levels. Furthermore, the literature acknowledges that various branches have different capacities to increase productivity, basically due to the varying capital-labor ratios in each activity (Baumol, 1967). This implies that high-technology industries have a lower capacity to create jobs in proportion to their growth and, in the long term, the relative weight of these companies in the overall labor composition tends to be reduced, producing negative consequences, because there are no significant carry-over effects to the sectoral degrees of aggregate productivity. In this sense, Rada and von Armim (2012) point out that for the overall productive apparatus, the relative weight of the labor factor falls as compared to capital, brought on by the process of technological modernization.

Based on that idea, Peneder (2003) hypothesized that there is a "structural burden," stating that the shift of workers from dynamic sectors to others with lower growth could negatively impact productivity. In fact, Peneder (2003) looked at data from 98 manufacturing categories for 16 European countries in the time period 1985-1998 using the Eurostat New Cronos database and confirmed that at the aggregate level, the effects of structural reallocation

[1] Ocampo (2005) offers an extensive definition of complementarities, referencing not only the role of backward and forward linkages, as described by Hirschman (1958), but also the role of public, private or mixed institutions created to reduce the costs of information.

have a lower impact on the evolution of sectoral labor productivity. The study also analyzed data from the United States, Japan and Canada and found evidence of a "structural burden," specifically by observing the expulsion of productive factors from dynamic industries with high growth in this indicator, a phenomenon robustly confirmed at a more disaggregated level for all European nations considered in the exercise, except Finland, Denmark and Great Britain.

One significant finding was that after classifying the industries into taxonomies, capital-intensive branches composed of high-technology industries, with more skilled jobs and/or jobs requiring services based on knowledge that traditionally produce stronger productivity growth, showed signs of negative structural effects. In fact, in these cases, it was confirmed that the relative weight of labor was reduced with the consequent expulsion of employment towards other activities, simultaneous to the growth of production and productivity. The article also highlighted the pronounced and systematic differences between the sectors, derived from technology gaps that have a negative impact on potential positive externalities, an aspect that Holland and Porcile (2005) pointed out as part of the phenomenon of growing within-sector heterogeneity in Latin America.

With regards to previously published literature, the main contribution of this work consists first of addressing the topic of structural change within manufacturing and on the most disaggregated level possible (four digits of the ISIC Rev. 3 classification for 150 activities) in a significant sample of countries with varying levels of development and geographic locations. Secondly, by decomposing the evolution of labor productivity with a shift-share technique that is rather more complete than those generally used in this type of study, this work contemplates the issue from the perspective of the technology content of each activity, aiming to dispute the popular sentiment that the most modern industries are capable of driving structural transformation with considerable carry-over effects for the rest of the manufacturing apparatus. In this regard, the results found in this work point in the direction of the relevance of investigating the weight of national complementarities and degrees of modernization, and systemic efficiency of the economy in determining the aggregate levels of sectoral productivity. Likewise, other germane aspects, such as the correlation between the degree of diversification, the density of the productive structure, and efficiency indicators merit an in-depth study that can only be addressed making use of more complex econometric techniques.

This work, therefore, aims first to confirm Peneder´s hypothesis in a group of 28 countries with varying levels of development and geographic locations, and then, analyze the contribution of technology-intensive industries to

sectoral efficiency, dividing 150 activities into four groups based on their technology content (High (H), Medium-High (MH), Medium-Low (ML) and Low (L)), pursuant to the OECD classification (OECD, 2005).

Do higher-technology activities contribute significantly to the growth of industrial labor productivity? If they do, is this contribution associated with a structural change (understood as the shift of workers from low-productivity uses to high-productivity uses)?

After describing the theoretical principles involved in this work and reviewing the most relevant findings of prior empirical studies related to industrial structural change in various countries by way of introduction, the second section summarizes the methodologies used, as well as the source and periodicity of the data for each of the various exercises. The third section presents the data and studies the various labor productivity trends as a function of the technology content of activities in 28 countries. Finally, the fourth section reveals the results obtained from applying the shift-share technique to the contribution of the four groups of activities to the evolution of aggregate labor productivity and structural change in the sector, while the last section debates the theoretical considerations presented in the introduction.

## 1. Methodology and Data

For the methodology to decompose the evolution of labor productivity, we follow Roncolato and Kucera (2014) who borrowed their mathematics from prior works conducted by other authors. Aggregate labor productivity of the industrial sector was calculated by dividing total value added by the total number of employees, or $q=X/L$. For each of the industries $i$ (or group of industries) that make up the sector, the indicator was then calculated as $q_i=x_i/l_i$ and total aggregate labor productivity as:

$$q = \frac{X}{L} = \frac{\sum x_i}{\sum l_i} \tag{1}$$

By taking into account first-order differences with respect to time (t=0), it turns out that the evolution of labor productivity can be expressed as:

$$\xi = \Sigma \{ \theta_{i0} (g_i - n_i) + \left[\theta_{i0} - \left(\frac{q_1}{q_0}\right) \lambda_{i0}\right] n_i\} \tag{2}$$

The derivation of equation (2) is thus:

$$\frac{q_i - q_0}{q_0} = [\sum x_{i1} \ / \ \sum l_{i1} - \sum x_{i0} \ / \sum l_{i0}] \ / \ [\sum x_{i0} / \sum l_{i0}] \ =$$
$$[\sum x_{i1} / \sum l_{i0} - \sum x_{i0} / \sum l_{i0} - \sum x_{i1} / \sum l_{i0} + \sum x_{i1} / \sum l_{i1}] \ / \ [\sum x_{i0} / \sum l_{i0}] \ =$$
$$[\sum x_{i0} / \sum l_{i0}] \ [\sum x_{i1} / \sum x_{i0} - \sum x_{i0} / \sum x_{i0} - (\sum x_{i1} \sum l_{i1}) \ / \ (\sum l_{i1} \sum x_{i0})$$
$$+ (\sum x_{i1} \sum l_{i0}) / (\sum l_{i1} \sum x_{i0})] / [\sum x_{i0} / \sum l_{i0}] \ =$$
$$\sum x_{i1} / \sum x_{i0} - \sum x_{i0} / \sum x_{i0} - (\sum x_{i1} \sum l_{i1} \sum l_{i0}) / (\sum l_{i1} \sum x_{i0} \sum l_{i0})$$
$$+ (\sum x_{i1} \sum l_{i0} \sum l_{i0}) / (\sum l_{i1} \sum x_{i0} \sum l_{i0}) \ =$$
$$(\sum x_{i1} - \sum x_{i0}) / \sum x_{i0} - [\sum x_{i1} \sum l_{i0} (\sum l_{i1} - \sum l_{i0})] / [(\sum l_{i1} \sum x_{i0} \sum l_{i0}) \ =$$
$$[1/\sum x_{i0}] \sum (x_{i1} - x_{i0}) - [q_i / q_0][1/\sum l_{i0}] \sum (l_{i1} - l_{i0}) =$$
$$\sum \{[(x_{i1} - x_{i0}) / x_{i0}] \ [x_{i0} / \sum x_{i0}]\}$$
$$- \sum \{(q_i / q_0) \ [l_{i0} / \sum l_{i0}] \ [(l_{i1} - l_{i0})] / l_{i0}]\} =$$
$$\sum \{[(x_{i1} - x_{i0}) / x_{i0}] \ [x_{i0} / X_0] \ - (q_i / q_0) \ [l_{i0} / L_0] \ [(l_{i1} - l_{i0}) / l_{i0}]\} =$$
$$\sum \left[\theta_{i0} g_i - \left(\frac{q_i}{q_0}\right) \lambda_{i0} n_i\right] =$$
$$\sum \left[\theta_{i0} g_i - \theta_{i0} \ n_i + \theta_{i0} \ n_i - \left(\frac{q_i}{q_0}\right) \lambda_{i0} n_i\right] =$$
$$\sum \left[\theta_{i0} (g_i - n_i) + \left(\theta_{i0} - \left(\frac{q_1}{q_0}\right) \lambda_{i0}\right) n_i\right]$$

We find that:

$$\xi = (q_1 - q_0) / q_0$$
$$n_i = (l_{i1} - l_{i0}) / l_{i0}$$
$$g_i = (x_{i1} - x_{i0}) / x_{i0}$$
$$\theta_{i0} = x_{i0} / X_0$$
$$\lambda_{i0} = l_{i0} / L_0$$

The evolution of labor productivity can now be decomposed into an intrinsic effect in contrast with the structural effects of labor reallocation.

The intrinsic effect is the first term on the right side of equation (2), that is:

$$\xi_w = \sum [\theta_{i0} (g_i - n_i)] \qquad (3)$$

This intrinsic effect is the difference between growth in value added and the growth in employment weighted by the share of industry in the total value

added for the sector. It reflects the increases in labor productivity associated with changing efficiencies within each of the activities and can be associated with the phenomenon of technological and organizational progress.

The interaction effect found here is represented by the quotient $q_1/q_0$ and translates into the difference between the growth in labor productivity and the sum of the intrinsic and structural effects of labor reallocation.

Finally, the structural effect is part of the second term on the right side of equation (2), that is:

$$\xi_r = \sum[\,(\theta_{i0} - \lambda_{i0})\, n_i] \tag{4}$$

This factorial reallocation effect is the difference between the participation of value added and employment in the sectoral totals multiplied by the growth of employment in the industry in question. It reflects the contribution of the shift of workers towards industries with above-average productivity to the evolution of the aggregate labor productivity of the sector, in other words, the contribution of structural change to the behavior of the efficiency indicator.

Broadly speaking, the contribution of each industry (or group of industries) to the variation in the aggregate labor productivity of the sector is the sum of the growth of labor productivity weighted by its share in the total value added (intrinsic effect) plus the increase in employment levels weighted by relative labor productivity (structural effect). Needless to say, the effects can be negative when factors shift towards less productive activities (structural effect); or when labor productivity decreases, due to technological obsolescence or regressive transformations in the organization, within different industries (intrinsic effect).

In this article, labor productivity at the level of categories grouped by technology intensity was calculated using the sum of the values added of the various activities that make them up, divided by the sum of the number of employees in the activities, values that correspond to the four-digit activities in ISIC Rev. 3 with consistently available information. For the groups studied here, the effects and their relative contributions were determined by adding the previously calculated effects of the activities belonging to each group. Similarly, and to prevent inconsistencies, the effects for the sector total were equal to the sum of the effects of each group considered.

It is notable that, as Roncolato and Kucera (2014) wrote, '…the larger the difference in labor productivity among sectors, the larger the potential

increases in aggregate labor productivity through reallocation effects, provided employment shifts from less to more productive sectors.' In this sense, we could expect that a high degree of structural heterogeneity, normally associated with rather less mature productive apparatuses, would have a positive correlation, particularly in developing countries, with the processes of structural change buoyed by the growing weight of technology-intensive industries.

In terms of information sources, after reviewing available resources, the choice was made to use the Industrial Statistics Database (INDSTAT) 4 2012 database under the ISIC Revision 3 classification created by the United Nations Industrial Development Organization (UNIDO), as it is the only source that standardizes the data obtained from various national industrial surveys for a significant number of countries (135) and activities (151). However, one issue with this source is that it does not have homogeneous time series for the entire set of activities and nations, so there are many gaps and inconsistencies. To resolve this problem for the exercises in this study, countries, time periods and activities were chosen based on the ability to obtain the most complete and consistent data series without producing any specific bias.

With that said, countries with the most information available on the most disaggregated level possible were selected (four digits in the ISIC Rev. 3 classification), aiming to achieve a relatively balanced geographic distribution and levels of development. Time periods were selected in each case by looking for the years with the most number of data entries, without any specific bias, using the average of each series as a reference. The data was then deflated to 2005 United States dollars, as this is a relatively stable international economic unit. The series used was the producer price index for all manufacturing industries published by the Bureau of Labor Statistics of the United States Department of Labor (BLS, 2014).

The only activities eliminated were those with no data for the first or last year of the period or those with very inconsistent behavior over time. As such, the time periods, number of years and activities considered in the exercise vary for each country, which in turn explains the presentation of some of the results in terms of the arithmetic rates of average annual growth in real prices, aiming to prevent imbalanced comparisons between cases. It should be noted, however, that the first and last years of the exercise were chosen for similar periods (between 1994 and 1998 for the first year and between 2005 and 2009 for the last year), except for Morocco (2000-2009), due to the lack of information.

Finally, the activities were regrouped based on their technology intensity into four categories (high, medium-high, medium-low and low), following the taxonomy created by the OECD (2005).

## 2. Labor Productivity by Groups of Technology Intensity in Selected Countries

Before presenting the statistical information, it is necessary to offer a few additional clarifications as to the limitations of the methodology used. First, as various classic authors have pointed out (Baumol, 1967; Scherer, 1982), technology flows among different activities and investment in R+D can explain some of the evolution of aggregate sectoral productivity. Scherer (1982) asserted the relevance of R+D directed towards creating or improving products used as inputs in determining the growth of productivity in sectors that manufacture final goods. According to him: "This tendency is likely to be mirrored in the distribution of measured productivity growth as price deflators systematically underestimate the hedonic value of new products and hence undervalue the inputs used by an innovating industry´s customers" (Scherer, 1982: 627).

Second, the regrouping of the activities into four categories of technology intensity pursuant to the OECD classification (and any other existing up to the present) does not allow us to distinguish the differences in capital intensity among the tasks effectively carried out in certain locations. In all sectors, tasks are carried out with differing factorial content and as a result, have different productivity levels. In the context of marked productive specialization patterns, the most efficient activities are generally associated with transnational companies inserted in global value chains that relocate productive segments based on their factorial content, so the contribution to aggregate sectoral productivity of a single activity may differ significantly from one country to another. Likewise, we note the importance of the degree of modernization of a country's physical infrastructure as an additional explanation for the differences in efficiency detected among countries. In this way, in some cases, labor productivity may be higher in low technology intensity sectors.

In this sense, and as a final clarification, the objective of this paper is not to question the relevance of R+D and innovation processes in general in determining productivity levels of aggregate sectoral productivity, but rather, on the contrary, to challenge the contribution, per se, sustained by abundant literature, of technology-intensive activities. As demonstrated by the results presented below, it will be necessary to conduct a detailed diagnosis of the contribution of the various industries in each specific national context in

connection with their levels and forms of articulation, both domestically and within global value chains. Although the methodological limitations do not permit a comprehensive approach to the topic of the role of the most "modern" industries in a potential structural change that would boost efficiency levels in the framework of developing the organization of international manufacturing, this is not considered to be a major obstacle in terms of the objectives set forth here.

Tables 1 and 2 present the participations of the four categories of activities grouped by technology intensity in the value added and total number of employees in the industrial sector for the 28 countries selected in the year 2005. The data indicate that on average, high-technology industries represent 11% of the sectoral value added, while the sum of the averages of the H and MH groups was 37%. On the country level, one initial observation is related to the apparent lack of a specific pattern for cases with a greater weight of activities of the first group in the total value added. In fact, nations where industries that are highly technology-intensive had a greater participation (Korea, Hungary and Finland), were of varied levels of development and different geographic locations.

Even so, when looking at the sum of the contributions of the first two groups (H and MH), the traditional production powerhouses are at the top of the list (Germany, 56% and Japan, 53%), which might suggest that medium-high technology activities generate both monetary benefits and benefits in terms of productive development equivalent to or even greater than high-intensity activities. In the other hand, Latvia stood out among countries with productive structures that are very concentrated on low-technology industries, as nearly 70% of the value added considered was generated by these activities, while in Ecuador, the sum of the H and MH groups represented only 8% of the total and in Iran, activities with higher technology content only represented a very low 3%.

Table 1

**Participation of Groups of Activities by Technology Intensity in the Total Value Added of the Sector in Selected Countries, 2005 (Percentages)**

| **Country** | **H** | **M** | **H+MH** | **ML** | **L** | **Total** |
|---|---|---|---|---|---|---|
| Germany | 13.17 | 42.58 | 55.75 | 23.07 | 21.18 | 100 |
| Austria | 12.48 | 29.79 | 42.27 | 28.80 | 28.94 | 100 |
| Belgium | 14.95 | 27.89 | 42.84 | 28.14 | 29.02 | 100 |
| Korea | 24.30 | 30.44 | 54.74 | 27.07 | 18.18 | 100 |
| Denmark | 21.20 | 22.20 | 43.39 | 23.48 | 33.13 | 100 |
| Ecuador | 1.30 | 7.18 | 8.48 | 50.84 | 40.68 | 100 |
| Slovakia | 6.97 | 26.39 | 33.36 | 40.77 | 25.87 | 100 |
| Spain | 5.93 | 26.23 | 32.16 | 32.33 | 35.51 | 100 |
| United States | 21.34 | 26.74 | 48.08 | 23.33 | 28.59 | 100 |
| Finland | 23.82 | 22.96 | 46.78 | 20.28 | 32.94 | 100 |
| France | 16.70 | 28.33 | 45.03 | 25.67 | 29.30 | 100 |
| Netherlands | 7.95 | 24.03 | 31.98 | 31.30 | 36.72 | 100 |
| Hungary | 23.73 | 36.57 | 60.30 | 15.25 | 24.45 | 100 |
| India | 8.35 | 31.06 | 39.41 | 37.75 | 22.84 | 100 |
| Indonesia | 7.47 | 27.43 | 34.90 | 12.99 | 52.11 | 100 |
| Iran | 3.38 | 36.26 | 39.63 | 44.06 | 16.31 | 100 |
| Italy | 9.16 | 27.39 | 36.55 | 30.81 | 32.64 | 100 |
| Japan | 16.56 | 36.92 | 53.48 | 23.80 | 22.72 | 100 |
| Jordan | 7.62 | 16.53 | 24.14 | 37.19 | 38.67 | 100 |
| Latvia | 5.80 | 9.28 | 15.08 | 16.04 | 68.88 | 100 |
| Lebanon | 1.12 | 18.67 | 19.79 | 27.41 | 52.80 | 100 |
| Morocco | 5.90 | 18.31 | 24.20 | 26.90 | 48.90 | 100 |
| Mexico | 7.29 | 32.23 | 39.52 | 26.19 | 34.29 | 100 |
| Norway | 8.94 | 19.33 | 28.27 | 32.16 | 39.57 | 100 |
| Poland | 5.92 | 21.20 | 27.13 | 33.76 | 39.12 | 100 |
| United Kingdom | 18.84 | 23.55 | 42.38 | 22.50 | 35.12 | 100 |
| Sweden | 16.35 | 32.73 | 49.08 | 23.53 | 27.38 | 100 |
| Turkey | 3.08 | 25.98 | 29.06 | 29.98 | 40.96 | 100 |
| **Simple Average** | **11.41** | **26.01** | **37.42** | **28.41** | **34.17** | **100** |
| Standard deviation | 7.15 | 7.95 | 12.59 | 8.49 | 11.53 | 0.00 |
| Coefficient of variation | 62.64 | 30.57 | 33.64 | 29.89 | 33.74 | 0.00 |

Source: Prepared by the author based on UNIDO (2012) data.

Table 2
**Participation of Groups of Activities by Technology Intensity in the Total Employment of the Sector in Selected Countries, 2005 (Percentages)**

| Country | H | MH | H+MH | ML | L | Total |
|---|---|---|---|---|---|---|
| Germany | 10.31 | 38.45 | 48.76 | 24.24 | 27.00 | 100 |
| Austria | 9.43 | 26.71 | 36.14 | 27.54 | 36.32 | 100 |
| Belgium | 9.21 | 25.25 | 34.46 | 27.86 | 37.68 | 100 |
| Korea | 17.94 | 29.27 | 47.21 | 26.64 | 26.15 | 100 |
| Denmark | 13.14 | 25.00 | 38.14 | 24.76 | 37.11 | 100 |
| Ecuador | 2.05 | 9.67 | 11.72 | 15.91 | 72.37 | 100 |
| Slovakia | 6.68 | 29.66 | 36.34 | 27.71 | 35.95 | 100 |
| Spain | 4.72 | 22.23 | 26.95 | 31.20 | 41.85 | 100 |
| United States | 14.27 | 24.16 | 38.43 | 26.23 | 35.34 | 100 |
| Finland | 13.95 | 24.21 | 38.16 | 22.67 | 39.17 | 100 |
| France | 12.59 | 25.74 | 38.33 | 26.51 | 35.16 | 100 |
| Netherlands | 5.31 | 23.45 | 28.76 | 28.97 | 42.27 | 100 |
| Hungary | 13.49 | 26.91 | 40.40 | 18.77 | 40.83 | 100 |
| India | 5.74 | 20.59 | 26.32 | 22.91 | 50.76 | 100 |
| Indonesia | 5.51 | 10.47 | 15.99 | 13.18 | 70.84 | 100 |
| Iran | 4.37 | 29.27 | 33.64 | 33.91 | 32.45 | 100 |
| Italy | 7.35 | 25.85 | 33.20 | 29.72 | 37.07 | 100 |
| Japan | 12.19 | 31.15 | 43.35 | 23.36 | 33.29 | 100 |
| Jordan | 4.67 | 11.70 | 16.37 | 28.46 | 55.18 | 100 |
| Latvia | 3.06 | 9.46 | 12.52 | 13.50 | 73.97 | 100 |
| Lebanon | 0.98 | 11.71 | 12.69 | 29.41 | 57.90 | 100 |
| Morocco | 2.85 | 12.72 | 15.57 | 15.84 | 68.60 | 100 |
| Mexico | 5.30 | 27.18 | 32.48 | 18.63 | 48.89 | 100 |
| Norway | 6.78 | 16.97 | 23.74 | 30.16 | 46.09 | 100 |
| Poland | 5.23 | 20.34 | 25.58 | 25.70 | 48.72 | 100 |
| United Kingdom | 12.92 | 23.45 | 36.37 | 25.10 | 38.53 | 100 |
| Sweden | 8.91 | 32.57 | 41.48 | 24.16 | 34.35 | 100 |
| Turkey | 1.96 | 17.99 | 19.95 | 24.76 | 55.29 | 100 |
| **Simple Average** | **7.89** | **22.58** | **30.47** | **24.56** | **44.97** | **100** |
| Standard deviation | 4.50 | 7.56 | 10.91 | 5.34 | 13.58 | 0.00 |
| Coefficient of variation | 57.03 | 33.48 | 35.82 | 21.74 | 30.19 | 0.00 |

Source: Prepared by the author based on UNIDO (2012) data.

In terms of the participation of the H and MH groups in the number of sector employees, the lower capacity of these activities to create jobs with respect to their productive capacity due to a higher capital-labor ratio was confirmed, as their average weight in the structure was only 8% and 23%, respectively. Once again, Korea saw the highest contribution of the first group to

employment and in Germany, the sum of H and MH accounted for nearly half of sectoral job positions. Another factor relatively unrelated to this article that may influence the behavior of the contributions of these groups to overall job creation and economic growth is the distribution of the activity income among benefits and wages and, consequently, on how rigid the labor legislation in each country is. In the Table 2 data, the role of low-technology activities in creating jobs in many developing countries which tend to be characterized by high levels of unemployment, such as Ecuador, Indonesia, Latvia and Morocco, was also worth noticing.

Table 3 presents labor productivity levels by activity group in selected countries for 2005, and the results were significant. As expected, because technology-intensive activities are more modernized and technified, they had higher labor productivity. However, the difference between the averages of the countries for the various groups was not as significant as might be believed. Specifically, the efficiency indicator for the MH group was only 3.3% higher than the figure for medium-low industries.

It was also corroborated that cases with the highest labor productivity in the group H were in turn those with the highest levels of total aggregate productivity (United States, Japan, Korea and Belgium, with the exception of Finland). In parallel fashion, nations with the lowest total aggregate indicators (India, Indonesia, Latvia, Slovakia, Morocco and Jordan) had the lowest levels of this indicator in nearly all groups defined, which underlines the importance of how modern the physical infrastructure is and the existence of complementarities in determining the efficiency of the various activities, especially, in the overall productive sector.

Table 3
**Labor Productivity by Groups of Technology Intensity in Selected Countries, 2005 (Current US Dollars)**

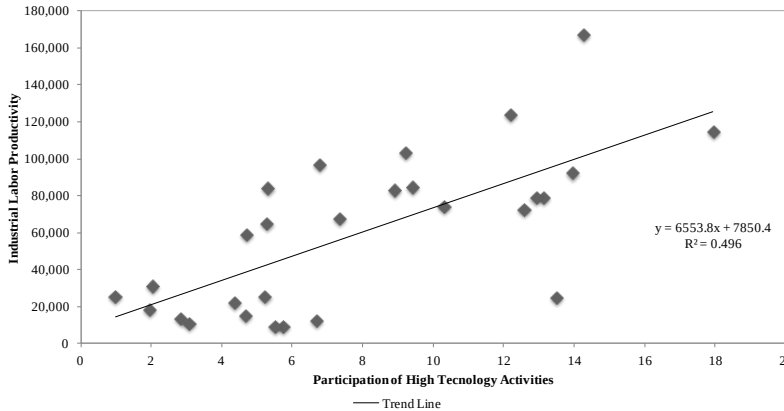
| Country | H | MH | H+MH | ML | L | Total |
|---|---|---|---|---|---|---|
| Germany | 94,724 | 82,179 | 84,833 | 70,627 | 58,189 | 74,195 |
| Austria | 112,317 | 94,631 | 99,245 | 88,746 | 67,614 | 84,865 |
| Belgium | 167,738 | 114,103 | 128,434 | 104,329 | 79,571 | 103,307 |
| Korea | 155,796 | 119,538 | 133,313 | 116,836 | 79,959 | 114,972 |
| Denmark | 127,664 | 70,249 | 90,025 | 75,039 | 70,631 | 79,118 |
| Ecuador | 19,853 | 23,228 | 22,638 | 100,024 | 17,592 | 31,295 |
| Slovakia | 13,245 | 11,300 | 11,658 | 18,684 | 9,136 | 12,698 |
| Spain | 74,341 | 69,745 | 70,549 | 61,238 | 50,152 | 59,107 |
| United States | 250,175 | 185,252 | 209,364 | 148,880 | 135,424 | 167,372 |
| Finland | 157,271 | 87,360 | 112,917 | 82,407 | 77,461 | 92,113 |
| France | 96,112 | 79,737 | 85,114 | 70,158 | 60,360 | 72,445 |
| Netherlands | 125,767 | 85,965 | 93,310 | 90,633 | 72,866 | 83,892 |
| Hungary | 44,140 | 34,089 | 37,445 | 20,383 | 15,018 | 25,085 |

| | | | | | | |
|---|---|---|---|---|---|---|
| India | 13,444 | 13,952 | 13,841 | 15,233 | 4,161 | 9,246 |
| Indonesia | 12,910 | 24,945 | 20,796 | 9,392 | 7,008 | 9,527 |
| Iran | 17,089 | 27,430 | 26,086 | 28,766 | 11,126 | 22,141 |
| Italy | 84,227 | 71,637 | 74,425 | 70,088 | 59,538 | 67,617 |
| Japan | 168,815 | 147,283 | 153,341 | 126,611 | 84,819 | 124,283 |
| Jordan | 24,814 | 21,510 | 22,453 | 19,891 | 10,667 | 15,221 |
| Latvia | 20,480 | 10,600 | 13,015 | 12,845 | 10,068 | 10,812 |
| Lebanon | 29,599 | 41,031 | 40,152 | 23,994 | 23,469 | 25,740 |
| Morocco | 27,806 | 19,372 | 20,918 | 22,858 | 9,593 | 13,457 |
| Mexico | 89,673 | 77,208 | 79,241 | 91,549 | 45,682 | 65,127 |
| Norway | 127,938 | 110,468 | 115,453 | 103,381 | 83,231 | 96,959 |
| Poland | 29,309 | 26,978 | 27,455 | 33,997 | 20,779 | 25,883 |
| United Kingdom | 115,781 | 79,760 | 92,558 | 71,185 | 72,403 | 79,427 |
| Sweden | 152,240 | 83,379 | 98,175 | 80,812 | 66,142 | 82,975 |
| Turkey | 29,343 | 27,019 | 27,248 | 22,652 | 13,857 | 18,706 |
| **Simple Average** | **85,093** | **65,712** | **71,571** | **63,616** | **47,018** | **59,557** |
| Standard deviation | 63,712 | 44,472 | 50,163 | 39,634 | 34,015 | 41,865 |
| Coefficient of variation | 75 | 68 | 70 | 62 | 72 | 70 |

Source: Prepared by the author based on UNIDO (2012) data.

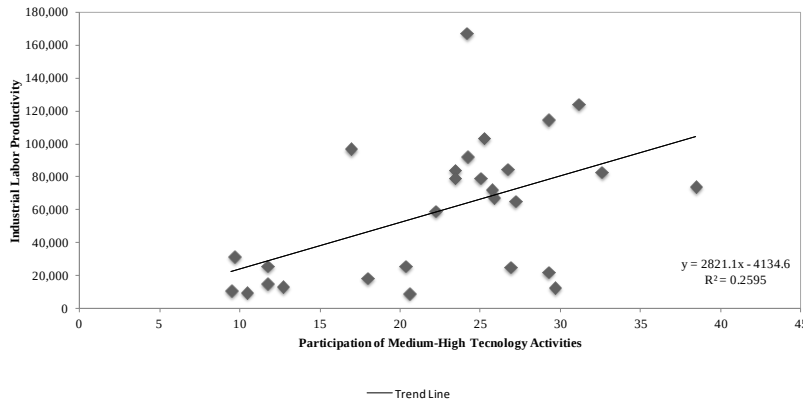
As such, another relevant observation was the apparent positive correlation between sectoral levels of aggregate productivity and the weight of technology-intensive industries in the structure. In fact, countries with a higher overall labor indicator (United States, Japan and Korea) only partially match cases with a higher share of high-technology activities (Korea, Hungary and Finland), as well as those with the highest weight of the sum of the H and MH groups in the structure (Germany, Korea and Japan). In this regard, Figures 1 and 2 show these associations, respectively, for the 28 countries analyzed. This first approximation confirms, although hardly in a robust fashion, what the previously reviewed literature indicates, that is, a positive correlation between the labor efficiency indicator and the weight of technology-intensive industries in the industrial structure, especially when considering only the group of high-technology activities (Figure 1).

Figure 1
**Industrial Labor Productivity and the Participation of High Technology Activities in the Structure of the Sector, 2005 (Current US Dollars and Percentages)**




Source: Prepared by the author based on UNIDO (2012) data.

Figure 2
**Industrial Labor Productivity and the Participation of High and Medium-High Technology Activities in the Structure of the Sector, 2005 (Current US Dollars and Percentages)**




Source: Prepared by the author based on UNIDO (2012) data.

Table 4 displays the annual average growth rates of labor productivity in real terms by groups of technology intensity for the countries selected. Once

again, the H group is the most dynamic, with an average increase of 7.1%. However, the ML group had a rate (6.3%) higher than the two other groups (MH (5.4%) and L (4%)). At first glance, it appears there is no correlation between the dynamism of the indicator and the technology content of the activities in this case. It is also notable that the cases with the strongest increases in aggregate labor productivity were all developing countries with high growth rate indicators in the set of groups (Indonesia, Slovakia, Hungary, Latvia and India). This is once again evidence for the systemic nature of the behavior of labor productivity in the industrial sector on the global level, as well as the greater potential for capital accumulation in developing countries.

Table 4

**Real Annual Average Growth Rates of Industrial Labor Productivity by Groups of Technology Intensity in Selected Countries (Percentages)**

| Country | H | MH | H+MH | ML | L | Total |
|---|---|---|---|---|---|---|
| Germany | 3.68 | 3.03 | 3.19 | 1.91 | -0.14 | 2.08 |
| Austria | 0.49 | 2.33 | 1.81 | 0.51 | 0.37 | 1.14 |
| Belgium | 6.19 | 2.11 | 3.45 | 2.94 | 2.73 | 3.17 |
| Korea | 7.12 | 6.50 | 6.91 | 3.79 | 4.90 | 6.26 |
| Denmark | 4.24 | 3.30 | 3.71 | 3.07 | 2.57 | 3.42 |
| Ecuador | 15.90 | 2.14 | 3.95 | 7.69 | 8.70 | 7.35 |
| Slovakia | 21.11 | 15.07 | 16.10 | 15.51 | 11.74 | 15.08 |
| Spain | 1.91 | 3.34 | 3.06 | 4.67 | 4.81 | 4.32 |
| United States | 3.36 | 1.93 | 2.50 | 3.79 | 2.63 | 2.83 |
| Finland | 11.47 | 1.33 | 5.10 | 1.95 | -0.88 | 1.91 |
| France | 2.96 | 2.42 | 2.61 | 2.81 | 3.70 | 3.09 |
| Netherlands | -2.18 | 1.69 | 0.81 | -0.52 | -0.76 | -0.21 |
| Hungary | 7.29 | 14.97 | 12.15 | 10.82 | 13.26 | 14.17 |
| India | 7.58 | 7.92 | 7.84 | 20.67 | 5.58 | 11.41 |
| Indonesia | 17.88 | 24.42 | 23.21 | 25.95 | 19.67 | 22.41 |
| Iran | 0.42 | 0.98 | 1.01 | 4.20 | -0.80 | 2.72 |
| Italy | 2.08 | 1.22 | 1.42 | 1.04 | 1.24 | 1.30 |
| Japan | 2.33 | 0.89 | 1.29 | 0.25 | -0.62 | 0.70 |
| Jordan | 13.16 | 8.02 | 9.53 | 7.32 | 5.31 | 6.36 |
| Latvia | 39.65 | 23.17 | 27.36 | 24.54 | 8.27 | 12.60 |
| Lebanon | -3.03 | -0.77 | -0.87 | -2.14 | -0.11 | -0.36 |
| Morocco | 11.47 | -1.51 | 0.45 | 9.85 | 4.28 | 5.20 |
| Mexico | 4.63 | 4.48 | 4.51 | 9.01 | 3.63 | 5.15 |
| Norway | 4.74 | 5.19 | 5.13 | 4.97 | 3.67 | 4.54 |
| Poland | 7.29 | 12.83 | 11.52 | 9.06 | 6.96 | 9.00 |
| United Kingdom | 5.12 | 3.58 | 4.33 | 4.35 | 3.94 | 4.21 |
| Sweden | 5.83 | 2.05 | 3.16 | 1.48 | 1.00 | 2.15 |
| Turkey | -3.91 | -2.42 | -2.64 | -1.92 | -3.06 | -2.48 |
| **Simple Average** | **7.10** | **5.36** | **5.81** | **6.34** | **4.02** | **5.34** |

| | | | | | | |
|---|---|---|---|---|---|---|
| Standard deviation | 8.75 | 6.80 | 6.87 | 7.37 | 4.93 | 5.50 |
| Coefficient of variation | 123.24 | 126.75 | 118.28 | 116.16 | 122.64 | 102.92 |

Source: Prepared by the author based on UNIDO (2012) data.

## 3. Results: Structural Change and Technology Intensity

This section summarizes the results obtained from applying the methodology to decompose the evolution of labor productivity (total effect) into two components: an intrinsic effect associated with technological and organizational changes within each activity or activity group, and a structural change, understood as the contribution of the shift of workers between industries with different levels of efficiency (see methodology section). Table 5 presents the contribution in percentage terms of the four groups of activities to the evolution of total aggregate productivity in industrial labor for the 28 countries.

Table 5
**Contribution to the Evolution of Industrial Labor Productivity by Groups of Technology Intensity in Selected Countries (Percentages)**

| Country | H | MH | H+MH | ML | L | Total |
|---|---|---|---|---|---|---|
| Germany | 22.61 | 65.99 | 88.60 | 19.88 | -8.49 | 100 |
| Austria | 3.81 | 59.98 | 63.80 | 12.75 | 23.45 | 100 |
| Belgium | 22.71 | 19.91 | 42.62 | 25.40 | 31.98 | 100 |
| Korea | 22.47 | 28.47 | 50.94 | 16.38 | 32.68 | 100 |
| Denmark | 19.37 | 21.49 | 40.86 | 20.25 | 38.89 | 100 |
| Ecuador | 3.80 | -1.62 | 2.18 | 73.80 | 24.02 | 100 |
| Slovakia | 11.14 | 18.54 | 29.68 | 35.20 | 35.12 | 100 |
| Spain | 3.56 | 23.02 | 26.58 | 31.10 | 42.32 | 100 |
| United States | 18.28 | 17.23 | 35.50 | 29.15 | 35.35 | 100 |
| Finland | 91.41 | 14.51 | 105.92 | 7.24 | -13.16 | 100 |
| France | 14.06 | 21.58 | 35.65 | 22.03 | 42.33 | 100 |
| Netherlands | 68.20 | -180.78 | -112.58 | 69.62 | 142.96 | 100 |
| Hungary | 12.52 | 37.95 | 50.47 | 11.00 | 38.53 | 100 |
| India | 6.72 | 26.21 | 32.94 | 66.38 | 0.68 | 100 |
| Indonesia | 5.73 | 31.76 | 37.50 | 13.94 | 48.56 | 100 |
| Iran | -1.03 | 31.28 | 30.25 | 77.19 | -7.44 | 100 |
| Italy | 13.73 | 26.54 | 40.27 | 22.69 | 37.04 | 100 |
| Japan | 32.48 | 32.74 | 65.22 | 9.42 | 25.36 | 100 |
| Jordan | 22.94 | 29.61 | 52.54 | 59.17 | -11.71 | 100 |
| Latvia | 12.08 | 20.24 | 32.33 | 20.42 | 47.26 | 100 |
| Lebanon | 12.44 | -99.83 | -87.39 | 190.16 | -2.78 | 100 |
| Morocco | 9.85 | -5.15 | 4.70 | 43.25 | 52.04 | 100 |
| Mexico | 5.95 | 27.33 | 33.28 | 35.44 | 31.28 | 100 |
| Norway | 8.31 | 20.10 | 28.41 | 32.39 | 39.20 | 100 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Poland | 5.38 | 30.51 | 35.88 | 31.34 | 32.78 | 100 |
| United Kingdom | 16.59 | 21.11 | 37.69 | 26.42 | 35.88 | 100 |
| Sweden | 45.40 | 29.02 | 74.42 | 11.38 | 14.20 | 100 |
| Turkey | 4.78 | -4.73 | 0.05 | -11.66 | 111.60 | 100 |
| **Simple Average** | **18.40** | **12.96** | **31.37** | **35.78** | **32.86** | **100** |

Source: Prepared by the author based on UNIDO (2012) data.

The data overwhelmingly reveal that groups with low technology-intensive activities (ML and L) had a higher contribution to the sectoral efficiency indicator, as the average contribution of the ML group (35.8%) and the L group (32.9%) was much higher than the contribution of the H (18.4%) and MH (13%) groups. In fact, in both developing countries with the highest rates of increasing aggregate labor productivity, with the exception of Hungary, (Indonesia, Slovakia, Latvia and India), as well as in the United States, a nation whose indicator was the highest in the sample, the contribution of low technology-intensive groups was higher than that of high and medium-high groups. The few cases in which the contribution of the H and MH groups was higher than that of the ML and L groups were generally characterized by high levels of productive development. However, this group is still rather heterogeneous, including countries such as Hungary and Jordan.

We are now able to answer the first of the questions proposed in the introduction; technology-intensive activities do not significantly contribute to the increase in the aggregate labor productivity of the sector. Broadly speaking, contrary to what the majority of works reviewed claim (Timmer and Szirmai, 2000; Silva and Teixeira, 2011), this result does not question the greater capacity of technology-intensive industries to accumulate capital and achieve higher levels of efficiency, but rather the degree of their contribution based on their theoretical importance to the aggregate industrial performance. This finding can be explained by the reduced weight of modern activities in the structure, both in terms of value added (Cimoli *et al*., 2005) and employment (Rada and von Armim, 2012), but as the result is verified although to varying degrees for countries with different levels of development. The hypothesis to prove in terms of the principal determinant of this result would then seem to be the scarce and unequal development of existing complementarities (Ocampo, 2011).

On this order of ideas, Table 6 shows the contribution in percentage terms of the intrinsic, structural and interaction effects to the evolution of the labor productivity of the sector. Negative data means that the labor indicator fell in the period indicated as a result of the aforementioned concepts. Similarly, because the sum of the three effects adds up to 100%, data above this amount implies a contribution of more than the entire increase in aggregate labor

productivity whose value exceeds 100%, logically compensated by the negative contribution of the sum of the remaining two effects. Once again, the results were rather conclusive. On average, the structural and interaction effects were negative, while the intrinsic component explained more than the entirety of the increase observed in the efficiency indicator (114.5%).

Table 6
**Determinants of the Evolution of Industrial Labor Productivity in Selected Countries (Percentages)**

| Country | Intrinsic Effect | Structural Effect | Interaction Effect | Total |
|---|---|---|---|---|
| Germany | 125.22 | -12.79 | -12.43 | 100 |
| Austria | 86.77 | 13.63 | -0.39 | 100 |
| Belgium | 83.90 | 7.60 | 8.50 | 100 |
| Korea | 91.31 | 6.20 | 2.49 | 100 |
| Denmark | 77.16 | 11.05 | 11.80 | 100 |
| Ecuador | 129.54 | 18.48 | -48.02 | 100 |
| Slovakia | 109.62 | -1.38 | -8.24 | 100 |
| Spain | 103.49 | 3.36 | -6.85 | 100 |
| United States | 76.07 | 3.83 | 20.09 | 100 |
| Finland | 119.03 | -12.23 | -6.80 | 100 |
| France | 79.31 | 2.84 | 17.85 | 100 |
| Netherlands | 105.71 | -9.32 | 3.61 | 100 |
| Hungary | 92.50 | 9.90 | -2.39 | 100 |
| India | 126.87 | 0.51 | -27.38 | 100 |
| Indonesia | 106.26 | 6.38 | -12.64 | 100 |
| Iran | 84.45 | 52.23 | -36.68 | 100 |
| Italy | 90.83 | 5.87 | 3.29 | 100 |
| Japan | 54.25 | 26.51 | 19.24 | 100 |
| Jordan | 254.46 | -48.34 | -106.12 | 100 |
| Latvia | 107.03 | 1.19 | -8.22 | 100 |
| Lebanon | 347.76 | -248.16 | 0.40 | 100 |
| Morocco | 107.84 | -5.81 | -2.02 | 100 |
| Mexico | 90.51 | 0.52 | 8.97 | 100 |
| Norway | 91.10 | 2.72 | 6.18 | 100 |
| Poland | 108.59 | -5.70 | -2.89 | 100 |
| United Kingdom | 68.81 | 4.72 | 26.48 | 100 |
| Sweden | 120.33 | -3.03 | -17.31 | 100 |
| Turkey | 167.01 | 109.09 | -176.10 | 100 |
| **Simple Average** | **114.49** | **-2.15** | **-12.34** | **100** |

Source: Prepared by the author based on UNIDO (2012) data.

In general terms, structural change, defined as the shift of workers between various activities, not only does not contribute to the increase of the indicator but also has a moderately negative impact on the behavior of aggregate labor

productivity. Upon examining the data, we find that in nine cases the structural effect was negative, while it was only positive and greater than 10% in six countries with extremely diverse levels of development (Denmark, Austria, Ecuador, Japan, Iran and Turkey). Lebanon (-248.2%) and Jordan (-48.3%) were also notable cases, where the sectoral recomposition of employment significantly hurt industrial performance. The above results therefore bring us to one of this work's objectives, by corroborating what other studies have concluded regarding the insignificant contribution of structural change to industrial efficiency on the global level (Timmer and Szirmai, 2000; Peneder, 2003; Holland and Porcile, 2005).

Table 7 expresses, in percentages, the contribution of the structural effect to the evolution of the labor productivity of the sector by activity group. The data confirm the low contribution of the worker shift to the performance of the aggregate indicator in all countries and for all groups. In only four cases did any of the groups have a share of more than 15% of the increase of the labor productivity of the sector due to this effect: Holland, where medium-high and medium-low technology activities contributed 24.8% and 17.6%, respectively, to aggregate evolution, Iran, where MH contributed 37%, and Japan and Turkey, where the L group participated with 45.2% and 100.4%, respectively. On average, no group of activities had a structural effect that represented more than 1% of the increase in the labor efficiency indicator, although the figure was on average positive for the H and MH groups and negative for the L and ML groups. What held true in both cases was that neither of the values was significant.

Table 7

**Contribution of the Structural Effect to the Evolution of Industrial Labor Productivity by Groups of Technology Intensity in Selected Countries (Percentages)**

| Country | H | MH | H+MH | ML | L | Total |
|---|---|---|---|---|---|---|
| Germany | -0.75 | -0.71 | -1.46 | -4.23 | -7.10 | -13 |
| Austria | -2.38 | 4.70 | 2.32 | -0.71 | 12.02 | 14 |
| Belgium | 3.06 | -0.65 | 2.42 | -0.17 | 5.36 | 8 |
| Korea | 4.75 | -2.47 | 2.28 | -1.73 | 5.65 | 6 |
| Denmark | 6.15 | 0.17 | 6.33 | -0.34 | 5.06 | 11 |
| Ecuador | -0.06 | 10.88 | 10.82 | 9.45 | -1.79 | 18 |
| Slovakia | -0.58 | -0.78 | -1.35 | -0.66 | 0.64 | -1 |
| Spain | -0.20 | 0.27 | 0.07 | -2.24 | 5.53 | 3 |
| United States | -4.35 | -2.77 | -7.12 | 1.98 | 8.97 | 4 |
| Finland | 7.91 | 1.40 | 9.31 | -8.59 | -12.94 | -12 |
| France | -0.72 | -1.71 | -2.43 | -0.65 | 5.93 | 3 |
| Netherlands | -11.93 | 24.77 | 12.84 | 17.63 | -39.79 | -9 |
| Hungary | 4.36 | 2.16 | 6.53 | -0.92 | 4.30 | 10 |

| | | | | | | |
|---|---|---|---|---|---|---|
| India | 1.25 | 0.93 | 2.18 | 1.35 | -3.02 | 1 |
| Indonesia | 0.07 | 5.04 | 5.11 | -0.23 | 1.50 | 6 |
| Iran | 1.93 | 37.02 | 38.96 | 2.69 | 10.59 | 52 |
| Italy | -0.26 | -2.41 | -2.68 | -3.38 | 11.93 | 6 |
| Japan | -0.40 | -13.95 | -14.35 | -4.33 | 45.19 | 27 |
| Jordan | 1.73 | -0.54 | 1.19 | -17.21 | -32.32 | -48 |
| Latvia | 1.44 | 1.05 | 2.49 | 0.34 | -1.64 | 1 |
| Lebanon | -0.07 | -60.02 | -60.08 | -29.31 | -158.78 | -248 |
| Morocco | 2.71 | -3.36 | -0.65 | -3.24 | -1.93 | -6 |
| Mexico | 0.21 | -1.45 | -1.24 | -0.74 | 2.50 | 1 |
| Norway | 0.29 | 1.32 | 1.61 | -0.57 | 1.69 | 3 |
| Poland | 0.35 | -0.29 | 0.06 | -2.86 | -2.91 | -6 |
| United Kingdom | -1.33 | -0.23 | -1.57 | 0.44 | 5.85 | 5 |
| Sweden | 5.10 | -0.24 | 4.87 | -5.02 | -2.88 | -3 |
| Turkey | 2.99 | 4.26 | 7.24 | 1.43 | 100.41 | 109 |
| **Simple Average** | **0.76** | **0.09** | **0.85** | **-1.85** | **-1.14** | **-2** |

Source: Prepared by the author based on UNIDO (2012) data.

In that sense, because there was no structural change that drove labor productivity in industry, in general terms, it could be said that the aforementioned low contribution of technology-intensive activities to the behavior of the aggregate indicator is neither associated with nor transmitted through a structural transformation that bolsters efficiency levels, regardless of the degree of productive development and the weight of the H and MH groups in the sector. As such, even though in countries with a greater share of high technology-intensive activities (Korea, Hungary and Finland) the contribution of the structural effect associated with these activities is slightly higher (although still not significant), in traditional production powerhouses with a considerable weight for the first two groups (H and MH) (Germany, Japan and the United States), the structural effect associated with these groups is even negative.

In summary, a greater share of technology-intensive activities in the industrial structure does not seem to be associated with either significant sectoral gains in labor productivity or with the shift of the labor factor towards more efficient uses. These results contradict findings by Cimoli and Porcile (2009) and Silva and Teixeira (2011) in terms of the positive and significant impact of modern industries on the increase of employment and aggregate labor productivity through a process of structural change. However, by contrast, they seem to confirm what Peneder (2003) found regarding the negative structural effects in his study (insignificant in ours) of capital-intensive branches composed of high-technology industries, with highly skilled jobs and/or requiring knowledge-based services.

It remains then to define whether, in line with Cimoli *et al*. (2005), the low contribution of H and MH activities to aggregate labor productivity is explained by the absence of structural change, because technological variables act indirectly through transformations to the productive structure, or whether, on the contrary, what we observed can be explained by the very incapacity of these capital-intensive industries, when they grow, to generate the externalities necessary for this transformation. As mentioned already, this paper defends a hypothesis that maintains that the simultaneous development of complementarities is essential to drive the carry-over effects necessary to achieve an authentic process of structural change.

## Conclusions

A variety of theoretical perspectives have defended the relevance of structural change that allocates manufacturing factors to higher productivity uses in an environment of growing productive specialization. This intuitively correct argument has been transferred to the industrial realm, specifically pointing to the example of the success of emerging Southeast Asian economies. However, the few works dedicated to analyzing structural change within industry have found, despite their multiple methodological limitations, scarce evidence of the significant contribution of the shift of productive factors to the increase in aggregate sectoral productivity in the current context of economic globalization.

Likewise, the literature, in addition to indicating that high-technology activities have higher levels of efficiency, has generally maintained the suitability of industrial upgrading towards a specialization pattern concentrated on capital-intensive activities. The strategic role of modern sectors in promoting structural change has thus been supported, arguing, among other things, that the articulated transformation of the manufacturing apparatus occurs automatically through the absorption of products and improved processes with higher technological content (Cimoli *et al*., 2005). As a result, various theoretical approaches have pushed for State support of high-technology sectors inserted in global chains and usually dedicated to exporting products.

However, few studies have consistently proved these assumptions. In this regard, the findings of this paper, which used an accounting technique to decompose the evolution of labor productivity, indicate that higher-technology activities do not contribute significantly to aggregate industrial labor productivity, regardless of the level of economic and productive development of the countries analyzed. In fact, the results overwhelmingly

demonstrate that groups that are less technology-intensive had, on average, a higher contribution to the increase in the sectoral efficiency indicator.

The exercises conducted here also corroborate, at a high level of disaggregation and with a sufficient number of cases, the absence of a structural change in industry that would drive levels of aggregate sectoral labor productivity. Consequently, there does not seem to be an association between the degree of participation of high-technology activities in the structure and the performance of the aggregate efficiency indicator or the potential shift of workers towards more profitable uses. This could be explained by the low capacity of capital-intensive activities to create jobs and generate the externalities and carry-over effects necessary for structural transformation. Another explanation may be related to what some authors have accepted as the challenges in disseminating innovations made at the core of industry to the rest of the manufacturing apparatus (David, 1985; Arthur, 1989).

Even so, a comprehensive view of productive development would have to emphasize the advance of national complementarities, considering a global context in which value chains are built and led by major transnational companies based on the phenomena of international segmentation and the dislocation of the various manufacturing activities. These global orders could, in and of themselves, explain the recent lack of development of the national complementarities necessary to produce carry-over effects and the other pecuniary externalities inherent to substantial structural change that would boost aggregate labor productivity. In summary, as Ocampo (2011) ascertained, there is currently a detachment between the technology content of products (especially export products) and the activities carried out by the various countries, where *maquila* processes are the extreme, as regardless of the technology intensity of the product, the tasks performed are strictly assembly and are of low domestic added value.

A worldwide context in which the governance of global value chains determines the national features of specialization based on tasks and not on activities with diverse technology content could then explain why developing countries, which have a greater capacity to accumulate capital, have higher labor productivity growth rates, but without a significant contribution of the structural component, as we might expect, according to Roncolato and Kucera (2014). In this regard, the results of this work start to provide a more comprehensive overview of what determines aggregate efficiency levels, that is, the role of the degree of modernization and systemic efficiency of the economy; an idea that should be taken into account to avoid drafting public policy measures that support highly technological industries divorced from the rest of the manufacturing structure.

With that said, some aspects of the theoretical reflections that have received less attention are still worthy of notice. For example, Cimoli and Porcile (2009) maintain that structural transformation and the consequent increase of aggregate labor productivity led by highly technological industries go hand in hand with productive diversification. In that sense, and in opposition to the current orthodox trend towards over-specialization, the density of the manufacturing apparatus is especially important, not only in the development of productive complementarities. Because all activities, regardless of their intrinsic characteristics, tend to play a rather significant systemic role, one final reflection is therefore linked to the criteria to analyze and determine relevant public policy, keeping in mind that the ultimate objective of productive development should be to promote the welfare of populations.

**References**

Arthur, W.B. (1989). "Competing Technologies, Increasing Returns and Lock-In by Historical Events". *Economic Journal*, 99(394), 116-131.

Baumol, W.J. (1967). "Macroeconomics of unbalanced growth: the anatomy of urban crisis". *The American Economic Review*, 57, 415-426.

BLS (2014). "Producer Price Index Industry Data". *U.S. Bureau of Labor Statistics*. Available at: <http://data.bls.gov/pdq/SurveyOutputServlet>

Bhagwati, J. (1988). *Protectionism*. Cambridge, UK: MIT Press.

Chenery, H.B., and Taylor, L. (1968). "Development patterns among countries and over time". *Review of Economics and Statistics*, 50, 391-416.

Chenery, H.B., Robinson, S., and Syrquin, M. (Eds.) (1986). *Industrialization and growth: A comparative study*. New York, NY: Oxford University Press.

Cimoli, M. (2005A). Introduction. In Cimoli, M. (Ed.), *Structural Heterogeneity, Technological Asymmetries and Growth in Latin America* (5-8). Santiago de Chile, Chile: CEPAL/BID.

Cimoli, M. (Ed.) (2005B). *Structural Heterogeneity, Technological Asymmetries and Growth in Latin America*, Santiago de Chile: CEPAL/BID.

Cimoli, M., Porcile G., Primi A., and Vergara, S. (2005). Structural Change, Productive Heterogeneity and Technology in Latin America. In Cimoli, M. (Ed.), *Structural Heterogeneity, Technological Asymmetries and Growth in Latin America* (9-38). Santiago de Chile, Chile: CEPAL/BID

Cimoli, M., and Porcile, G. (2009). "Sources of learning paths and technological capabilities: an introductory roadmap of development processes". *Economics of Innovation and New Technology*, 18(7), 675-694.

David, P. (1985). "Clio and the economics of QWERTY". *American Economic Review*, 75(2), 332-337.

Dosi, G. (1982). "Technological paradigms and technological trajectories: a suggested interpretation of the determinants and directions of technical change". *Research Policy*, 11(3), 147-162.

Fagerberg, J. (2000). "Technological progress, structural change and productivity growth: a comparative study". *Structural Change and Economic Dynamics*, 11, 393-411.

Fei, J., and Ranis, G. (1961). *Development of the Labour Surplus Economy: Theory and Policy*. Homewood, Ill: R. D. Irwing.

Furtado, C. (1963). Capital formation and economic development. In Agarwala, A., and Singh, S. (Eds.), *The Economics of Underdevelopment* (309-337). New York, NY: Oxford University Press.

Grossman, G., and Helpman, E. (1991). *Innovation and Growth in the Global Economy*. Cambridge, UK: MIT Press.

Hirschman, A. (1958). *The Strategy of Economic Development*. New Haven, CT: Yale University Press.

Hoffmann, W.G. (1958). *The growth of industrial economies*. Manchester, UK: Manchester University Press.

Holland, M., and Porcile, G. (2005). The Technology Gap and Growth in Latin America. In Cimoli, M. (Ed.), *Structural Heterogeneity, Technological Asymmetries and Growth in Latin America* (40-71). Santiago de Chile, Chile: CEPAL/BID

Jorgenson, D. (1961). "The development of a dual economy". *Economic Journal*, 71(282), 309-334.

Lewis, A. (1955). *The Theory of Economic Growth*. Homewood, Ill: R. D. Irwing

Lucas, R. (1988). "On the mechanics of economic development". *Journal of Monetary Economics*, 22, 3-42.

Nelson, R. R., and Pack, H. (1999). "The Asian miracle and modern growth theory", *Economic Journal*, 109, 416-436.

Ocampo, J. (2005). The quest for dynamic efficiency: structural dynamics and economic growth in developing countries. In Ocampo, J. (Coord.), *Beyond*

*Reforms. Structural Dynamics and Macroeconomic Vulnerability* (3-44). Washington, D.C: Stanford University Press.

Ocampo, J. (2011). "Macroeconomy for development: countercyclical policies and production sector transformation". *CEPAL Review*, 104, 7-35.

OECD (2005). "Science, Technology and Industry Scoreboard 2005." *Organization for Economic Cooperation and Development*. París, France: OECD.

Peneder, M. (2003). "Industrial structure and aggregate growth". *Structural change and economic dynamics*, 14, 427-448.

Peres, W., and Primi, A. (2009). "Theory and Practice of Industrial Policy. Evidence from The Latin American Experience". *Comisión Económica para América Latina y el Caribe.* Santiago de Chile: CEPAL.

Pieper, U. (2000). "Deindustrialization and the social and economic sustainability nexus in developing countries: cross-country evidence on productivity and employment". *Journal of Development Studies*, 36(4), 66–99.

Rada, C., and Von Arnim, R. (2012). "Structural transformation in China and India: A note on macroeconomic policies". *Structural change and Economic Dynamics*, 23(3), 264-275.

Roncolato, L., and Kucera, D. (2014). "Structural drivers of productivity and employment growth: a decomposition analysis for 81 countries". *Cambridge Journal of Economics*, 38, 399-424.

Scherer, F. M. (1982). "Inter-industry technology flows and productivity growth". *Review of Economics and Statistics*, 64, 627–634.

Silva, E.G., and Teixeira, A. A. C. (2011). "Does structure influence growth? A panel data econometric assessment of 'relatively less developed' countries, 1979-2003". *Industrial and corporate change*, 20(2), 457-510.

Syrquin, M. (1988). Patterns of structural change, in Chenery, H.B. and Srinivasan, T.N. (Eds.), *Handbook of development economics* (203-273). Amsterdam: North-Holland.

Timmer, M. P., and Szirmai, A. (2000). "Productivity in Asian manufacturing: the structural bonus hypothesis examined". *Structural Change and Economic Dynamics*, 11, 371-392.

UNIDO (2012). "Indstat 4 2012. ISIC Rev.3" *Database* [CD-ROM]. *United Nations Industrial Development Organization.* Vienna, Austria: UNIDO.

WB (2014). "GDP per capita." *World Bank*. Available at: <http://datos.bancomundial.org/indicador/NY.GDP.PCAP.CD>.

*Ensayos Revista de Economía–Volumen XXXV, núm.2, noviembre 2016, pp. 151-174*

# Informalidad, productividad y crecimiento en México, 2000.Q2- 2014.Q4

## *Informality, Productivity and Growth in Mexico, 2000.Q2-2014.Q4*

Eduardo Loría[*]
Malinalli Aupart[**]
Emmanuel Salas[***]

Fecha de recepción: 28 IX 2015 Fecha de aceptación: 01 VI 2016

**Resumen**

El desmedido aumento del sector informal, tradicional válvula de escape del mercado laboral, ha condicionado un lento crecimiento de la economía mexicana desde la década de los ochenta.

A partir de una lectura del modelo de Lewis (1954), proponemos que el crecimiento de la informalidad en México ha creado limitantes al crecimiento de largo plazo, mediante una sistemática reducción de la productividad factorial total.

[*] Autor principal. Profesor tiempo completo del Centro de Modelística y Pronósticos Económicos (CEMPE), Facultad de Economía, UNAM, Edificio B, tercer piso, cubículo 305. Dirección: Circuito Interior s/n, CU, México, Distrito Federal. C.P. 04510. Teléfono: 5622 2142 y 5622 2143. Correo electrónico: eduardol@unam.mx

[**] Becaria del Centro de Modelística y Pronósticos Económicos (CEMPE), Facultad de Economía, UNAM, Edificio B, tercer piso, cubículo 305. Dirección: Circuito Interior s/n, CU, México, Distrito Federal. C.P. 04510. Teléfono: 5622 2142 y 5622 2143. Correo electrónico: malimaliaupart@gmail.com

[***] Investigador del Centro de Modelística y Pronósticos Económicos (CEMPE), Facultad de Economía, UNAM, Edificio B, tercer piso, cubículo 305. Dirección: Circuito Interior s/n, CU, México, Distrito Federal. C.P. 04510. Teléfono: 5622 2142 y 5622 2143.Correo electrónico: salas.emmanuel@gmail.com

Agradecemos el financiamiento del proyecto "México: crecimiento, ciclos y precarización laboral 1980-2020". PAPIIT IN-302514, DGAPA, UNAM. Agradecemos los comentarios de los árbitros de la revista y la colaboración técnica de Iván Ramírez. Los autores son los únicos responsables de lo que aquí se dice o se omite.

La estimación de un Vector de Corrección de Error VECM(4) aporta evidencia de la reducción de la productividad debido al crecimiento del sector informal, que asociado a un lento crecimiento hace que se perpetúe un círculo vicioso de la improductividad, muy difícil de romper.

***Clasificación JEL***: D24, E26, E24, O4.
***Palabras Clave*:** informalidad, crecimiento económico, productividad factorial total, exogeneidad débil, Vector de Corrección de Errores.

## Abstact

The huge growth of the informal sector, the labor market relief valve, has conditioned the low Mexican economic growth since the early 1980´s.

From a Lewis (1954) model´s review, we propose that the growth of informality has limited economic growth, through the systematically factorial productivity reduction.

A VECM(4) supports evidence about the factorial productivity reduction by the informal sector growth, associated to slow Mexican economic growth to perpetuate the productivity vicious circle too hard to break.

***JEL Classiffication***: D24, E26, E24, O4.
***Keywords***: Informality, economic growth, total factor productivity, weak exogeneity, Vector Error Correction.

*"En el corto plazo la productividad no lo es todo, pero en el largo plazo es casi todo" Paul Krugman (1997)*

## Introducción

Uno de los problemas más acusados en la economía mexicana es la baja tasa de crecimiento que se observa desde el inicio de la década de los ochenta, aunque paradójicamente se han tenido tasas de desempleo relativamente bajas con respecto no solo a economías de la OCDE, sino también con otras de similar tamaño y desarrollo.

Se observa desde entonces una economía de lento crecimiento con bajo desempleo, en donde el factor trabajo no es escaso. El aparente debilitamiento de la relación propuesta por Okun (1962) tiene una explicación en el crecimiento del sector informal, que tradicionalmente ha sido una de las válvulas de alivio del mercado laboral en México.

El sector informal no es una masa homogénea sino que, por el contrario, nos encontramos frente a un fenómeno difícil de medir y conceptualizar, que la OIT (2012) ha definido como el conjunto de actividades y personas con una situación institucional irregular que provoca un acceso marginal, en el mejor de los casos, a las oportunidades de financiamiento que, por ende, reduce la capacidad de acumulación de capital y predispone la creación de entidades productivas, cuyos procesos están basados no en el capital sino en la incorporación de trabajo, con la característica de ser poco productivo al estar poco calificado en relación con el personal de las unidades formales.

El sector informal se caracteriza -entre otras cosas- por tener una menor intensidad de capital que genera menores salarios, pero con la capacidad de hacer crecer su volumen de ocupación y producto con menor inversión. Loría, Libreros y Salas (2012) muestran en un modelo de dos sectores para la economía mexicana que el sector sujeto a una menor intensidad de capital, por su mayor componente de trabajo informal, tiene una relación más débil entre desempleo y crecimiento, lo que ofrece respuesta a la relativa baja tasa de desempleo que registra la economía mexicana.

De esta manera, nos encontramos ante una circunstancia en donde la baja tasa de desempleo, por el crecimiento del sector informal, ha modelado una economía con un importante y creciente sector de baja productividad, que se asocia y a la vez condiciona un lento crecimiento debido a que la baja razón capital-trabajo desincentiva a la Productividad Total Factorial (PTF), único motor de crecimiento de largo plazo, el cual no se explica por los incrementos/decrementos de los diferentes factores que se involucran en la producción (INEGI, 2013), lo que sumerge a la economía en una espiral descendente en términos de desarrollo y crecimiento.

Esta inercia es muy difícil de romper, debido a una circunstancia de selección adversa de parte de los agentes que se ven orillados a emplearse en sectores de baja productividad, por dos razones. Por un lado, porque tienen la necesidad de un ingreso, porque los demás miembros de sus familias tienen salarios bajos que no permiten que un solo sujeto sea el proveedor de toda la familia; y, adicionalmente, porque presentan características de productividad inferiores a las que requiere el sector formal, que les ofrecería un salario más alto que permitiría a los demás miembros de la familia no incorporarse precozmente al sector informal, y adquirir, así, las capacidades laborales que les permitan alcanzar un empleo formal, obviamente mejor remunerado, para salir, tanto en lo individual como colectivamente, de la trampa de pobreza. El objetivo central de este artículo radica en verificar tanto teórica como econométricamente la relación negativa entre el crecimiento del sector informal y la PTF.

Además de la introducción, el artículo está estructurado de la siguiente manera: Primero, se hace una revisión de la literatura que expone la situación de la informalidad en términos generales y que plantea que la presencia de un sector de baja intensidad de capital, y por ende de baja productividad, es una condición que provoca un lento crecimiento de la PTF. En el siguiente apartado, se muestran los hechos estilizados sobre la evolución de las variables de interés y en particular sus comportamientos derivados de las dos crisis que se observan en el periodo de estudio (2001-2003 y 2009 en adelante). En el tercer apartado, se muestran los aspectos econométricos y se analizan y discuten los resultados principales. Por último, se presentan las conclusiones y algunos comentarios finales.

## 1. Aspectos teóricos y revisión de literatura

Desde hace varias décadas, la informalidad ha adquirido reconocimiento internacional para ingresar en las agendas de políticas públicas de los gobiernos; y desde hace unos años, los conceptos han ganado gran importancia, principalmente en economías emergentes por sus múltiples implicaciones en el crecimiento y desarrollo económicos. Se acepta que la informalidad es un fenómeno multifacético y multifactorial que aqueja a la economía mexicana, y que se ha vuelto un problema estructural desde la década de los ochenta.

Ochoa (2011) argumenta que el crecimiento del sector informal en México se ha asociado a los efectos de la crisis económica de los años ochenta, ya que a partir de entonces, se registraron fuertes disminuciones del crecimiento del PIB, de la PTF y del empleo formal.

### *1.1. Informalidad, productividad y crecimiento*

La literatura convencional del desarrollo sugiere que el crecimiento económico es un proceso uniforme de trasformación del producto y de todos los sectores de la economía. Pero en economías no desarrolladas, la pobreza, la desigualdad, el crecimiento de la población y los problemas de los mercados laborales, no responden así, no necesariamente. Bien puede ser que el crecimiento tenga efectos desiguales y que este proceso beneficie diferenciadamente a sectores sociales y económicos (Debraj, 2008).

Según el Banco Mundial (2008), la informalidad ha ganado creciente atención porque ha afectado el crecimiento económico y el bienestar social, y se ha convertido en una fuerza corrosiva para la integridad de las sociedades en Latinoamérica.

La Organización Internacional del Trabajo (2011) define a la economía informal como el conjunto de actividades económicas desarrolladas por los trabajadores y las unidades económicas que, tanto en la legislación como en la práctica, están insuficientemente contempladas por sistemas formales o no lo están en absoluto. Las actividades de esas personas y empresas no están recogidas dentro de la ley, lo que significa que se desempeñan al margen de ella; o no están contempladas en la práctica. Es decir, que si bien estas personas operan dentro del ámbito de la ley, esta no se aplica o no se cumple; o la propia ley no fomenta su cumplimiento por ser inadecuada, engorrosa o imponer costos excesivos.

Existen diversas opiniones en torno a la informalidad. Algunos autores, como Cimoli, Primi y Pugno (2006) y Levi (2008), proponen que hay efectos negativos hacia el crecimiento económico, ya que los empleos generados por este sector son de baja productividad y deprimen la PTF, con lo que comprometen el crecimiento futuro del conjunto de la economía. Señalan que cada vez más la informalidad es un rasgo persistente y distintivo de las economías latinoamericanas, y no solo tiene efectos adversos en el desempeño del crecimiento, sino que también en la economía en términos de exclusión, marginalización, precariedad y disparidades de salarios.

Levy (2008), Ochoa (2011) y Ros (2013) hacen referencia a que, por su naturaleza, las actividades informales se desarrollan con bajos niveles de inversión, capital físico y humano y productividad. De esta forma, un sector informal grande afecta la utilización eficiente de los recursos de toda la economía.

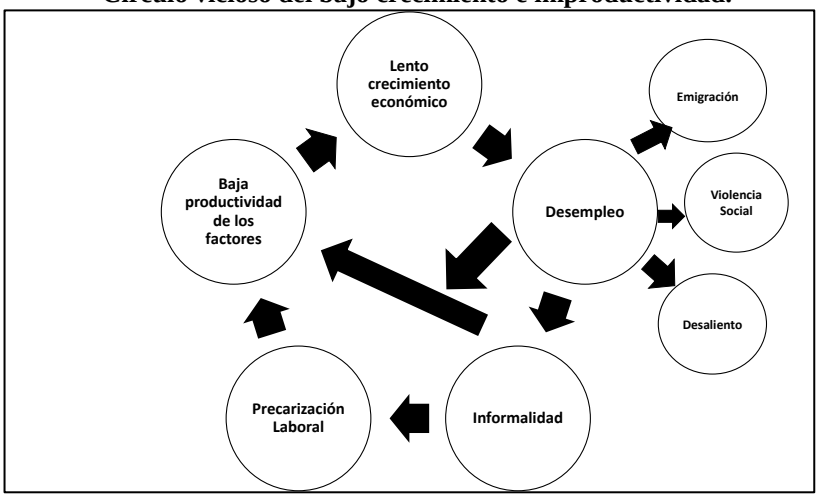
Es por todas las razones anteriores que la economía informal está asociada (y no necesariamente es la causa inicial)[1] a un menor ritmo de crecimiento del producto interno bruto (PIB), con baja productividad y, lo que es más importante, con generación de empleos precarios (salarios bajos y flexibles y sin prestaciones sociales).

Si bien hay una gran discusión sobre la causalidad: crecimiento económico – informalidad, aquí evidenciamos que lo que ha prevalecido en nuestro país es que la caída del crecimiento de PTF y del producto han generado un círculo vicioso de improductividad.

[1] De hecho, esta es la hipótesis del actual gobierno, por lo que el Plan Nacional de Desarrollo 2013-2018 (2013) define, como un eje primario, la formalización de la economía como instrumento central para elevar la productividad y poder alcanzar el máximo potencial de la economía.

Aquí consideramos que el círculo vicioso inicia con el lento crecimiento del PIB que se asocia a la caída secular de la PTF, lo que ha provocado que el desempleo crezca. De esta suerte, la teoría de la elección racional (Becker, 1968) afirma que las válvulas de escape son la informalidad (Maloney, 2004), el desaliento, la emigración (Figueroa, Ramírez, Gonzáles, Pérez y Espinosa, 2012) y la violencia social (crimen organizado). Lo anterior a su vez genera precarización del mercado de trabajo, con lo que se cierra el círculo vicioso ya descrito que, finalmente, se plasma en precarización laboral y preservación de la pobreza, y en fuertes contrastes sociales (ver diagrama 1).

Diagrama 1
**Círculo vicioso del bajo crecimiento e improductividad.**




Fuente: elaboración propia.

Resulta pertinente plantear que muchos de los grandes problemas que México enfrenta como la pobreza, la informalidad, el rezago educativo y de salud, el financiamiento del sistema de pensiones y la violencia social proveniente del crimen organizado son, en buena parte, resultado de la falta de crecimiento y de la precarización de los mercados laborales.

Sin entrar en discusiones ni en controversias, es plausible considerar que entre las causas del bajo crecimiento están el agotamiento del modelo de desarrollo seguido desde los años cincuenta, la falta de adopción de uno

nuevo y exitoso y el tipo de inserción en el mercado mundial que experimentó la economía mexicana, a mediados de la década de los noventa[2].

Como consecuencia del círculo vicioso ya descrito, los empleos que se han generado en México en los últimos años han sido en su mayoría informales (Samaniego, 2008). Dicho de otro modo, la informalidad se ha convertido en una opción de sobrevivencia y, adicionalmente, de rentabilidad. La primera se refiere a que se pertenece a este sector de la economía como medio de subsistencia. La segunda se refiere a que al pertenecer a este sector se evaden importantes costos de la formalidad, como: pago de impuestos y servicios públicos, regulación y seguridad laboral, entre otros.

De Soto (1986) utiliza el concepto de costo de la formalidad y costo de la informalidad para explicar la elección racional de los agentes económicos. Ubica la condición de informalidad en situaciones de demanda agregada y parcial fluctuantes, derivadas de la precariedad y la reducción del crecimiento y a la vez aumento de la volatilidad de la economía mundial y nacional.

Este enfoque denominado de subsistencia es el que toma la economía del desarrollo para explicar el surgimiento del sector informal en la economía. Lewis (1954), Harris y Todaro (1970), entre otros, retoman este modelo, en el cual los determinantes de la informalidad se refieren a pobreza, ingresos y nivel de educación, y a que la existencia de dos sectores, el formal y el informal, sugieren que podría existir un puente entre ambos en la medida en que crezca vigorosamente el sector formal, lo que no se ha visto desde 1982.

Maloney (2004) señala que la informalidad es una opción paralela al empleo formal y que estos dos sectores ofrecen trabajos deseables con características distintas, que los trabajadores escogen de acuerdo con su preferencia. Muestra que la informalidad en México representa no solo un "colchón" para los desempleados del sector formal, sino que también es una alternativa laboral con sus propias características atractivas para los trabajadores, y es una vía de escape para los (pequeños) empresarios.

Desde 1982, México ha experimentado un periodo de lento crecimiento, sin embargo, la tasa de desempleo es más baja de lo que se esperaría, en función de otras economías, pues teóricamente, como lo plantea Okun (1962), existe una relación causal bidireccional negativa entre el crecimiento económico y

[2] Si bien es imperioso detectar y analizar causas últimas de la reducción secular del crecimiento económico, este propósito rebasa por completo el objetivo de este trabajo. Sin embargo, aquí sugerimos algunas relaciones estructurales fundamentales que pueden ayudar a tal fin.

la tasa de desempleo, pero para el caso de México está relación ha sido menor a la esperada, pues aun cuando las tasas de crecimiento han sido bajas, el desempleo se ha mantenido en un rango de 2% a 5%, lo cual conduce a la pregunta: ¿por qué la tasa de desempleo no se ha elevado notablemente, aun con tasas bajas de crecimiento?

Loría *et al.* (2012) encuentran en un estudio sobre la ley de Okun, que para el caso de México, al segmentar a la economía en dos sectores, aquella con una menor intensidad de capital y favorecida por una mayor presencia de informalidad, reportaba una relación más débil entre desempleo y crecimiento que el sector más intensivo en capital y con un mayor componente formal. Lo que lleva a pensar que en México el crecimiento del sector informal es la condición básica para el bajo desempleo, en una ambiente de bajo crecimiento.

*1.2. Modelo teórico*

Lewis (1954) parte de una oferta de trabajo infinitamente elástica en los países en desarrollo; con este supuesto básico, describe el comportamiento de una economía "dual" que produce un bien y en la que coexisten un sector atrasado y un sector moderno.

Para analizar la relación negativa entre la PTF y el empleo del sector informal $L_i$, usaremos de base la formalización de Ros (2001), que se sustenta en el modelo de Lewis (1954), en donde se asume una economía que produce el mismo bien en dos sectores.

El sector moderno (formal) *Y* es intensivo en capital *K* y el sector de subsistencia *I* lo es en trabajo.

$$Y = AK^{\alpha}(L_f)^{\beta} \quad (1)$$

$$I = w_i L_i \quad (2)$$

En la (3) despejamos *A* ─que es la PTF─ de la ecuación del sector formal, e introducimos al empleo informal mediante la propuesta de que es una proporción relativamente fija del empleo formal, ecuación (4).

$$A = YK^{-\alpha}L_f^{-\beta} \quad (3)$$

$$L_f = \phi L_i \; donde \; \phi > 0 \quad (4)$$

$$A = YK^{-\alpha}(\phi L_i)^{-\beta} \quad (5)$$

Definimos la elasticidad PTF del empleo informal en (6).

$$\varepsilon_{A,L_i} = \frac{\partial A/\partial L_i}{A/L_i} \tag{6}$$

En (7), desarrollamos en numerador de (6) y en (8), simplificamos términos.

$$\varepsilon_{A,L_i} = \frac{-\beta Y K^{-\alpha} \phi^{-\beta} L_i^{-\beta-1}}{A/L_i} \tag{7}$$

$$\varepsilon_{A,L_i} = \frac{-\beta Y K^{-\alpha} \phi^{-\beta} L_i^{-\beta}}{A} \tag{8}$$

Por la ecuación (4), sustituimos $(\phi L_i)^{-\beta}$ por $L_f{}^{-\beta}$. En la ecuación (10), agrupamos los términos de *A*, *K*, $L_f$ en el denominador y simplificando, se llega a (11), que expresa la relación negativa de la elasticidad PTF del empleo informal, que se iguala con la elasticidad PIB del empleo formal. Esta ecuación es central para el propósito de nuestra hipótesis, la que se prueba econométricamente en la sección 3.

$$\varepsilon_{A,L_i} = \frac{-\beta Y K^{-\alpha} L_f^{-\beta}}{A} \tag{9}$$

$$\varepsilon_{A,L_i} = \frac{-\beta Y}{A K^{\alpha} L_f^{\beta}} \tag{10}$$

$$\varepsilon_{A,L_i} = -\beta \tag{11}$$

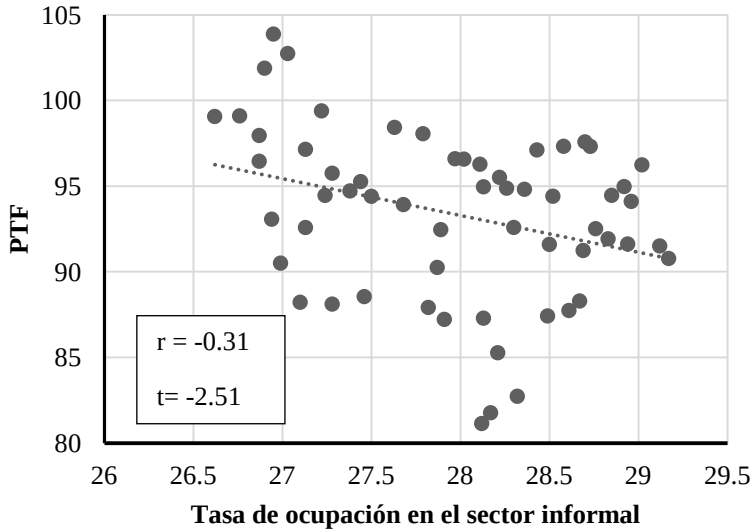
## 2. Hechos estilizados

A partir de este momento, cuando nos refiramos a informalidad estaremos hablando específicamente de la Tasa de Ocupación en el Sector Informal (TOSI), la cual se refiere a la población ocupada que trabaja para una unidad económica que opera a partir de los recursos del hogar, pero sin constituirse como empresa. Esta definición no es igual a la que se refiere a la informalidad laboral, pues este otro concepto añade las categorías de trabajo no protegido, servicio doméstico, trabajadores subordinados en empresas formales pero sin registro de seguridad social (INEGI, 2014).

Debido a que no existen datos oficiales previos de la TOSI, el análisis empírico partirá de 2000.Q2. A continuación analizaremos una serie de hechos que nos sirven para poder sugerir relaciones importantes entre las variables que nos ocupan y que, finalmente, configuran el modelo econométrico.

En la gráfica 1, tenemos la relación de TOSI con la PTF, y podemos observar que existe una clara relación negativa que además es estadísticamente significativa.

Gráfica 1
**Diagrama de dispersión PTF vs. tasa de ocupación en el sector informal, 2000.Q2-2014.Q4**

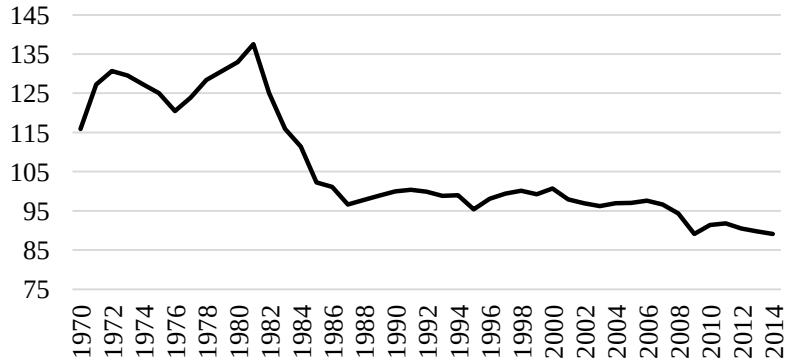



Fuente: cálculos propios basados en el Plan Nacional de Desarrollo (2013-2018) e INEGI (2014).

Siguiendo a Pagés (2010), Sala-i-Martin y Artadi (1999) y Romer (2002), el principal determinante del crecimiento de largo plazo de una economía es la PTF. En México, entre 1990 y 2014, esta variable registró un caída media anual de 0.6%. En la gráfica 2, podemos observar que es a partir de 1982, cuando comienza a caer estrepitosamente, justo cuando se inicia una larga depresión económica que duró hasta 1988.

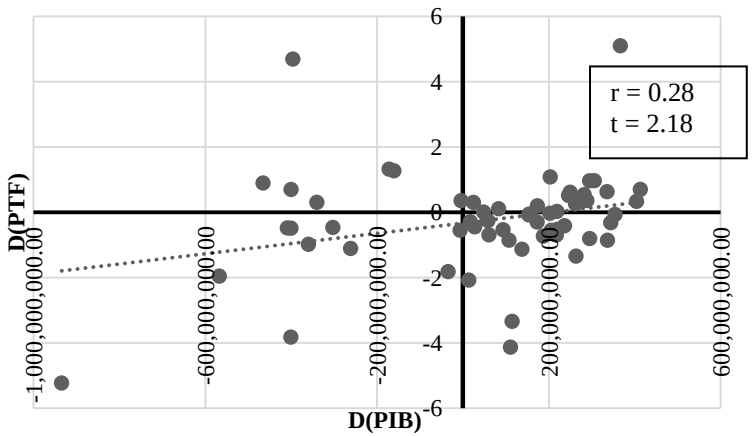
En la gráfica 3, se demuestra la relación PTF-PIB, que nos conduce al inicio del círculo vicioso de la improductividad y el bajo crecimiento, ya mencionados; lo que se prueba econométricamente en la siguiente sección.

Gráfica 2
**México: productividad total de los factores (PTF), 1970-2014**
**1990 = 100**




Fuente: Plan Nacional de Desarrollo (2013-2018) e INEGI (2015). Nota: pronóstico para 2012-2014 calculado por un ARIMA (3, 1, 3).

Gráfica 3
**Diagrama de dispersión PTF vs. PIB, 2000.Q2-2014.Q4**




Fuente: Plan Nacional de Desarrollo (2013-2018) e INEGI (2015).

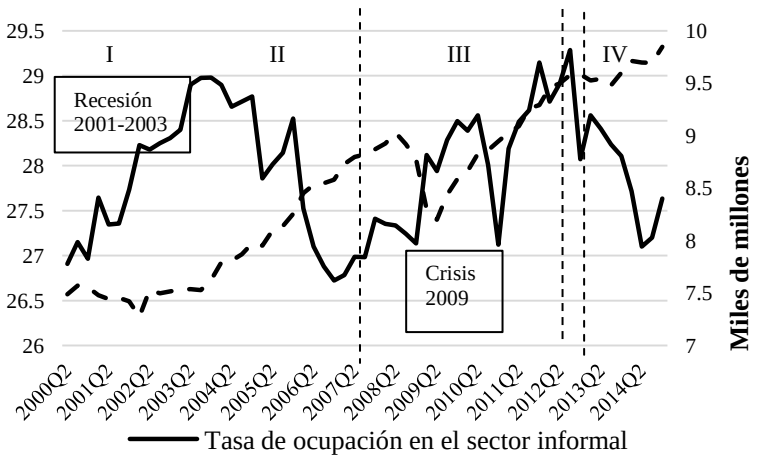
Por otro lado, en la gráfica 4, observamos la evolución de TOSI y el PIB. La gráfica está dividida en cuatro secciones. En la primera, que corresponde al periodo 2000.Q2-2003.Q3, ocurrió una larga recesión, por lo que la informalidad creció muy rápidamente. En la segunda sección (2003.Q4-2008.Q2), el PIB se recuperó notablemente y la informalidad cayó

sustancialmente. En estos dos periodos, se observó la relación que sugiere la teoría y que se presenta en el diagrama 1.

Sin embargo, en la tercera y cuarta secciones (2008.Q3- 2012.Q2 y 2012.Q3-2014.Q4), se observa la caída del producto por la gran recesión de 2009 y, a pesar de su recuperación, la informalidad muestra un comportamiento errático y creciente hasta 2012.Q2, que en adelante (cuarto periodo) se reduce mucho, aun en presencia del PIB, que reduce sustancialmente su crecimiento. Esta nueva relación denota un fuerte cambio estructural que merece un análisis particular; pues fue en 2013, cuando entró en vigor la Reforma Laboral y en 2014, la Reforma Hacendaria con la que el gobierno federal impulsó el programa *"*Crezcamos juntos*"*, para formalizar al empleo que se desempeñaba en condiciones de informalidad. Como se observa en la cuarta sección, la informalidad muestra una caída, pues según datos oficiales se formalizaron 4.3 millones de negocios. Este análisis es preliminar y se requerirá de mucho más tiempo para ver los efectos (permanentes o transitorios) de estas reformas.

Gráfica 4

**México: tasa de ocupación en el sector informal y PIB, 2000.Q2-2014.Q4 -series desestacionalizadas-**




Fuente: cálculos propios con información de INEGI (2014). Nota: series desestacionalizadas con el método ARIMA X12.

## 3. Aspectos econométricos

Con el fin de formalizar estadísticamente las regularidades ya referidas de largo plazo, particularmente verificar la relación negativa entre la PTF y el empleo en el sector informal, como se propuso en la ecuación 11, se estimó un modelo de cointegración (Johansen, 1988), en virtud de que todas las variables son I(1) (ver cuadro 1A en el anexo). Las pruebas de la Traza y Max-Eigen de valor indican que al 95% de confianza existe una sola ecuación de cointegración (ver cuadro 2A de anexo).

Se definió el sistema de información (Y) para el periodo 2001.Q2-2014.Q4, en el que existe cointegración con las variables de interés: PIB ($y$), PTF ($p$)[3], y la tasa de ocupación en el sector informal ($i$)[4].

$$Y = \{i_t, y_t, p_{t,}\} \tag{12}$$

La especificación general de un VECM es:

$$\Delta Y_t = \Pi Y_{t-1} + \sum_{i=1}^{p} \Gamma \Delta Y_{t-p} + \varepsilon_t \tag{13}$$

Donde $\Pi = \alpha\beta'$

$$ptf_t = 15.67 - 0.2947 i_t - 0.4444 y_i + e_t \tag{14}$$
$$t \qquad\qquad (-2.1950) \quad (-13.9105)$$

Corrección de error

$$\alpha_{ptf} = -0.2846 \quad \alpha_i = -0.2067 \quad \alpha_y = -0.0084$$
$$t \qquad (-4.2694) \qquad (-1.8600) \qquad (-0.0759)$$

La ecuación 14 reporta los resultados de la estimación y pasa todas las pruebas de correcta especificación[5]. El mecanismo de corrección de error es significativo y tiene el signo correcto, lo que demuestra que hay un ajuste dinámico trimestre a trimestre sobre la PTF. Se usó una dummy de correcta especificación, que toma el valor de 1 en 2009.1.

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[3] La serie es anual y se trimestralizó mediante el método Chow y Lin (1971), como se ve en el anexo estadístico.

[4] Todas las variables se expresan en logaritmos, por lo que los parámetros estimados son elasticidades constantes.

[5] LM (7) = 9.48 (0.39); Lütkepohl = 8.02 (0.23); White N.C. = 177.35 (0.19); 2 tendencias comunes, raíz máxima 0.9683.

Los signos son los esperados, encontramos evidencia de la relación negativa entre informalidad (i) y PTF. El signo del parámetro ajusta a lo propuesto en la ecuación (11), en donde se propuso que el valor de la elasticidad productividad informalidad es en términos absolutos igual a la elasticidad producto del trabajo formal. Se obtuvo el signo negativo de PIB a PTF, que prueba la evidencia analizada en los hechos estilizados en que el lento crecimiento del PIB se ha asociado a una reducción sistemática de PTF. Para ser más enfáticos, apreciamos que buena parte del crecimiento se asocia a un crecimiento extensivo en el uso del factor trabajo del sector informal, y no a un crecimiento intensivo que genere productividad.

La motivación de normalizar el vector de cointegración sobre PTF, además de la hipótesis central del artículo, radica en la presencia de exogeneidad débil[6] de las demás variables (Johansen, 1992; Juselius, 2006; Smith y Harrison, 1995 y Lanteri, 2011), y de que el sistema de información solo cuenta con un vector de cointegración.

La simulación histórica (gráfica 5) se utilizó como un elemento adicional para demostrar la correcta especificación en la medida que muestra la gran capacidad de replicación del modelo, a todos los datos históricos, sin excepción.

En el apartado teórico que se expresa en el diagrama 1 y la ecuación 11, se establecieron relaciones causales entre las variables que conforman el sistema de información y que la ecuación de cointegración prueba con claridad.

Los impulsos-respuesta (ver gráfica 6) corroboran los resultados anteriores y prueban el signo de las relaciones. Con el fin de ser muy específicos en esta parte del análisis, puntualizaremos cada respuesta relevante derivada de los impulsos:

1. Se observan efectos negativos, permanentes y significativos de las variables *p* y *y* sobre *i*, gráficas 6b y 6d.
2. En las gráficas 6a y 6c se prueba que la informalidad deprime las variables *p* y *y*, particularmente la primera de manera mucho más clara y permanente[7].
3. La gráfica 6e prueba el efecto positivo de *p* sobre *y*.

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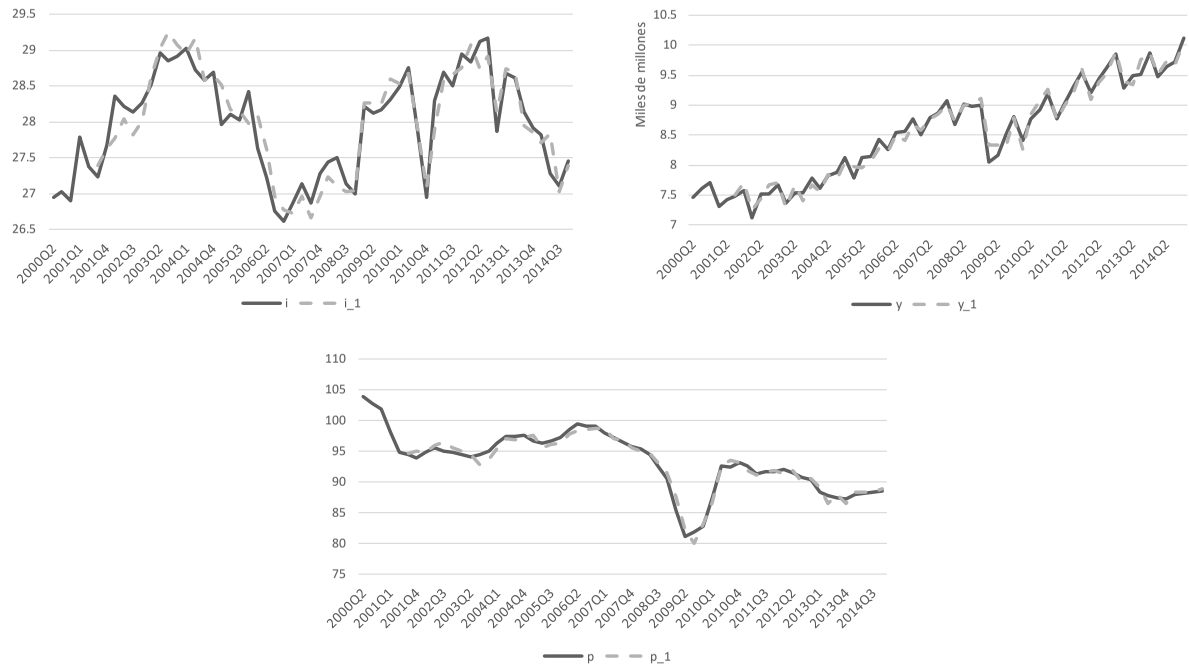
[6] Lanteri (2011) demuestra la exogenidad débil mediante la falta de significancia estadística de los parámetros de corrección de error, en este caso $\alpha_y, \alpha_i$ cumplen esa condición al 95% de confianza. Esa condición no es válida al 90%, lo que permitiría endogeneizar a la informalidad en el caso de tener un segundo vector de cointegración.

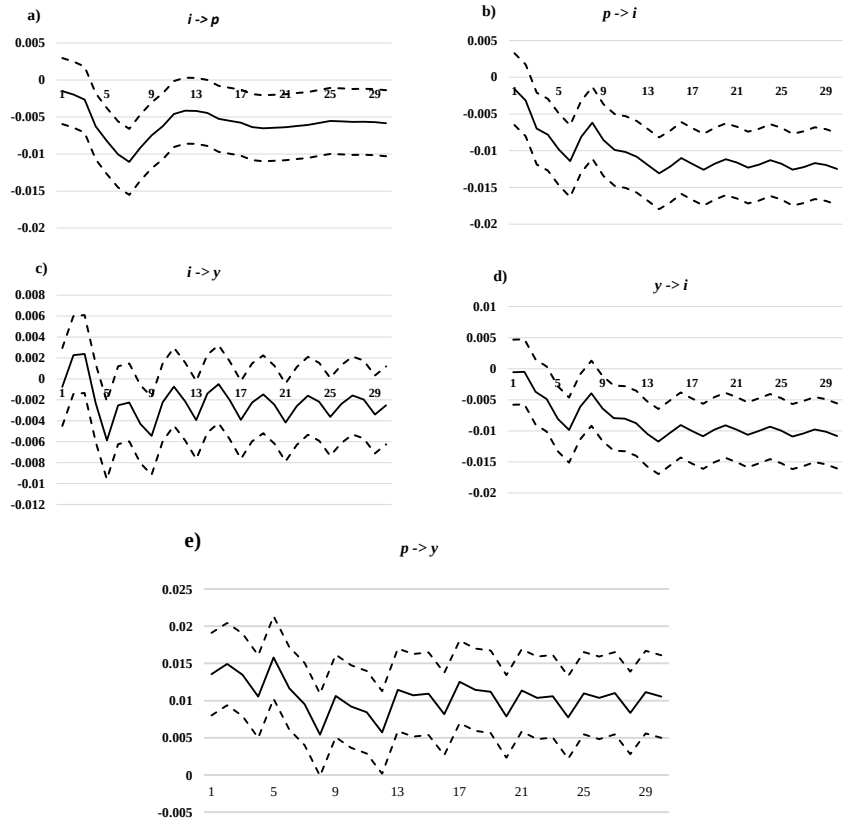
[7] Es muy probable que el efecto intermitente en 6c obedezca a la fuerte estacionalidad de *y*. Sin embargo, claramente se observa el efecto negativo, permanente y significativo, por lo menos hasta 29 trimestres.

Gráfica 5
**Simulación histórica con algoritmo de Broyden**




Fuente: Elaboración propia con base en la simulación del modelo

Gráfica 6
**Impulsos – respuesta generalizados**




Fuente: Elaboración propia con base en los resultados del modelo. Nota: Las bandas de confianza se calcularon con el método de Bootstrap (método percentil) con mil iteraciones que permite obtener la desviación estándar de la muestra al 95% de confianza. Se utiliza el método de impulsos generalizados para evitar la sensibilidad al ordenamiento del sistema (Pesaran, Shin y Smith, 2001).

Adicionalmente, una prueba inferencial muy relevante para probar la interacción de las variables, se realiza mediante la descomposición de la varianza. Esta prueba es un estudio complementario para el análisis impulso-respuesta, y que informa -en distintos horizontes del tiempo- sobre el porcentaje de volatilidad que registra una variable debido a los choques de las demás (ver cuadro 1).

Cuadro 1
**Descomposición de la Varianza**

| | *p* | | | | *y* | | | | *i* | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Periodo | S.E. | *p* | *i* | *y* | S.E. | *p* | *i* | *y* | *S.E* | *p* | *i* | *y* |
| 1 | 0.0085 | 100 | 0 | 0 | 0.0142 | 59.942 | 0.205 | 39.852 | 0.0142 | 0.0889 | 99.911 | 0 |
| 10 | 0.0298 | 66.47 | 21.95 | 11.57 | 0.0363 | 60.998 | 3.661 | 35.339 | 0.0397 | 12.297 | 86.821 | 0.8807 |
| 20 | 0.0317 | 59.07 | 27.88 | 13.03 | 0.0462 | 60.635 | 3.272 | 36.091 | 0.0589 | 20.256 | 78.7 | 1.0427 |
| 30 | 0.0337 | 52.85 | 32.3 | 14.84 | 0.0547 | 60.321 | 3.149 | 36.528 | 0.0743 | 22.967 | 75.853 | 1.1792 |

Fuente: Elaboración propia con base en los resultados del modelo.

Encontramos que la PTF reacciona, de manera importante, tanto en el corto como en el largo plazo, a la informalidad; de hecho, se aprecia que en el periodo 30, la relación es alrededor del doble que la que tiene con el producto. Respecto del producto, el epígrafe de Krugman se valida al mostrar que más de la mitad de la variación dinámica del producto, se debe a la productividad. Por último, apreciamos el peligroso fenómeno del sector informal que se explica a sí mismo, lo que justifica lo difícil que es salir del círculo vicioso de bajo crecimiento, que promueve la misma alta informalidad.

## Conclusiones y comentarios finales

El bajo crecimiento de la economía mexicana desde 1982 se ha asociado a una caída estrepitosa de la productividad total factorial, lo que sumado a cambios estructurales, la recesión de 2001-2003 y la crisis de 2009, han afectado de manera importante los mercados laborales, aumentando el desempleo, la precarización laboral y el empleo informal.

No es arriesgado afirmar que esta red de causalidades ha configurado un círculo vicioso de bajo crecimiento e improductividad que asola el tejido social y económico de México.

Por otro lado, el crecimiento del empleo informal no solo es un problema del bajo crecimiento económico de México; esto es, no se trata de un problema que se enfrenta únicamente desde el punto de vista macroeconómico, sino que también debe observarse en el nivel microeconómico, en la medida que los agentes toman la decisión de insertarse en este sector, como una alternativa o elección racional ante el desempleo.

La informalidad es un fenómeno muy complejo, y son diversas las causas que han alentado el crecimiento de esta variable representativa del mercado laboral de países en desarrollo y, particularmente, de México.

Para probar la hipótesis de que la informalidad deprime la PTF se estimó un VECM(4) para el periodo 2000.Q2-2014.Q4.

La emigración, por su parte, ha disminuido en estos últimos años, lo que señala que ahora una importante válvula de escape ante el desempleo ya no es emigrar a Estados Unidos, sino buscar en México una alternativa ante el desempleo, como lo es el empleo informal.

Lo anterior nos lleva a concluir que ahora la informalidad es una opción ante la situación de desempleo, aunque también se puede concluir que el estatus de empleado informal ahora ya no responde, como en el pasado, al desempleo ni a la actividad económica, sino básicamente a la baja productividad factorial; y, en los últimos dos años, a reformas estructurales muy difíciles de evaluar en sus efectos de largo plazo.

El desempleo y la informalidad son consecuencia del estancamiento que ha tenido el crecimiento y la caída de la productividad total de los factores, desde comienzos de la década de los ochenta.

La productividad total de los factores, por su parte, es una de las variables que más ha resentido la baja actividad económica, los cambios estructurales y las crisis económicas; lo que también es, a su vez, una de las causantes del lento crecimiento de la economía mexicana.

Es por todos los hechos anteriores, que se habla de un círculo vicioso de bajo crecimiento e improductividad, lo que da pauta para poder hablar de una bicausalidad entre productividad total factorial y crecimiento económico e informalidad, que a diferencia de otros autores, como Levy (2008), solo se basan en la causalidad: informalidad – crecimiento económico, y viceversa.

La informalidad es un fenómeno bastante complejo y no existe un consenso sobre cómo erradicarlo; sin embargo, parecería que se ha reducido recientemente debido a las reformas fiscales definidas desde 2013, aunque es necesario considerar que esto tendrá un límite en la medida que el crecimiento económico siga siendo bajo y la productividad factorial continúe decreciendo.

Se puede concluir que, en materia de política pública, aún se está haciendo un esfuerzo por reducir los niveles del empleo informal, pero los resultados no son muy claros. El gobierno tendría que ver este complejo problema desde todas las perspectivas y no solo tomando en cuenta que la informalidad es la causante del bajo crecimiento económico.

Finalmente, este trabajo brinda herramientas para construir un marco explicativo de la evolución del crecimiento económico, de la productividad y –principalmente- de la informalidad, que en los últimos 15 años han tenido cambios importantes en su comportamiento y en las relaciones entre estas variables.

## Referencias

Becker, G. (1968). *The Economic Approach to Human Behavior*. Chicago, USA: University of Chicago Press

Banco Mundial (2008). "Concept of Informal Sector". *Banco Mundial.* Disponible en: http://lnweb90.worldbank.org/eca/eca.nsf/1f3aa35cab9dea4f85256a77004e4ef4/2e4ede543787a0c085256a940073f4e4

Chow, G. y Lin, A. (1971). "Best linear unbiased interpolation, distribution, and extrapolation of time series by related series". *The Review of Economics and Statistics*, 53, 372-375.

Cimoli, M., Primi, A., y Pugno, M. (2006). "Un modelo de bajo crecimiento: la informalidad". *Revista de la CEPAL*, 88, 89-107.

De Soto, H. (1986). *El otro sendero*. Lima, Perú: El Barranco.

Debraj, R. (2008). *Economía del desarrollo*. Barcelona, España: Antoni Bosch editor.

Figueroa, E., Ramírez, O., Gonzáles, M., Pérez, F. y Espinosa, L. (2012). "Análisis del desempleo, la migración y la pobreza en México". *Revista Mexicana de Negocios.* Vol. 16, 835-847.

Harris, J. R., & Todaro, M. P. (1970). Migration, unemployment and development: a two-sector analysis. *The American Economic Review*, 60 (1), 126-142.

INEGI (2013). "Sistema de Cuentas Nacionales de México: productividad total de los factores 1990-2011". *Instituto Nacional de Estadística y Geografía*. México: INEGI. Disponible en: http://www.inegi.org.mx/prod_serv/contenidos/espanol/bvinegi/productos/derivada/cuentas/bienes%20y%20servicios/produc_total/product_total_90_11/PTF_SCNM.pdf

INEGI (2014). "Encuesta Nacional de Ocupación y Empleo". *Instituto Nacional de Estadística y Geografía*. México: INEGI. Disponible en: http://www.inegi.org.mx/est/contenidos/proyectos/encuestas/hogares/regulares/enoe/.6 de Marzo de 2013.

INEGI (2015). "Productividad total de los factores modelo KLEMS Serie anual 1990 – 2011. Boletín de investigación núm. 02/13." *Instituto Nacional de Estadística y Geografía*. México: INEGI.

Johansen, S. (1988). "Statistical analysis of cointegration vectors". *Journal of economic dynamics and control*, 12, 231-254.

Johansen, S. (1992). Testing weak exogeneity and the order of cointegration in UK money data. *Journal of Policy Modeling*, 14, 313-334.

Juselius, K. (2006). *The cointegrated VAR model: methodology and applications*. Oxford, England: Oxford University Press.

Krugman, P. R. (1997). *The age of diminished expectations: US economic policy in the 1990s*. Massachusetts, USA: MIT Press.

Lanteri, L. (2011). "Choques macroeconómicos en la agricultura: Alguna evidencia para la economía argentina". *Investigación Económica*, 70, 75-100.

Levy, S. (2008). *Good Intentions, Bad Outcomes: Social Policy, Informality, and Economic Growth in Mexico*. Washington, D.C., USA: Brookings Institution Press.

Lewis, W. A. (1954). "Economic development with unlimited supplies of labour". *The Manchester School*. 22, 139-191.

Litterman, R. (1983). *"*A Random walk, Markov model for the distribution of time series". *Journal Business and Economics Statistics*, 1, 169-173.

Loría, E., Libreros, C. y Salas, E. (2012). "La ley de Okun: una mirada de género para México 2000.II-2011.I". *Investigación Económica*, Universidad Nacional Autónoma de México. Facultad de Economía., 280, 121-140.

Maloney, W. (2004). "Informality Revisited". *World Development*, 32 (7), 1159-1178.

OIT (2012). "Medición de la economía informal." *Oficina Internacional del Trabajo.* Ginebra: OIT. Disponible en: http://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_policy/documents/publication/wcms_229450.pdf

Ochoa, S. (2011). *Economía informal; evolución reciente y perspectivas*, México D.F., México: Centro de Estudios Sociales y de Opinión Pública.

Okun, A. M. (1962). "Potential GNP: its measurement and significance". In *Proceedings of the Business and Economic Statistics Section of the American Statistical Association*, 7, 89-104.

Pagés, C. (2010). *La era de la productividad: cómo transformar las economías desde sus cimientos*. Washington, D.C., USA: Inter-American Development Bank.

Pesaran, M. H., Shin, Y. & Smith, R. J. (2001). "Bounds testing approaches to the analysis of level relationships". *Journal of Applied Econometrics*, 16(3), 289-326.

Plan Nacional de Desarrollo (2013-2018): "Programa para la democratizar la Productividad. México." *Secretaría de Hacienda y Crédito Público.* México: SHCP.

Romer, D. (2002). *Macroeconomía avanzada*. Tercera edición, Madrid, España: McGraw-Hill.

Ros, J. (2001). *Development theory and the economics of growth*. Michigan, USA: University of Michigan Press.

Ros, J. (2013). *Algunas tesis equivocadas sobre el estancamiento económico de México*. México: Facultad de Economía, UNAM.

Sala-i-Martin, X. & Artadi, E. V. (1999). En Antoni Bosch (Ed.), *Apuntes de crecimiento económico*. Barcelona, España.

Samaniego, N. (2008). "El crecimiento explosivo de la economía informal." *Economía UNAM*, 5, 30-41.

Smith, A. D. & Harrison, R. (1995). "A drunk, her dog and a boyfriend: an illustration of multiple cointegration and error correction". Department of Economics and Operations Research, University of Canterbury. Disponible en: http://www.econ.canterbury.ac.nz/downloads/amsta

## Anexo estadístico

Cuadro 1A
**Pruebas de raíz unitaria**

| | *i* | Δ*i* | *p* | Δ*p* | *y* | Δ*y* |
|---|---|---|---|---|---|---|
| | | | ***Intercepto Y Tendencia*** | | | |
| **PP** | -2.54* | -8.7 | -2.70* | -3.86 | -4.34 | -19.83 |
| **KPSS** | 0.11 | 0.11 | -7.46 | -1.32 | 0.07 | 0.11 |
| | | | ***Intercepto*** | | | |
| **PP** | -2.70* | -18.99 | -2.33* | -3.87 | -1.07* | -18.99 |
| **KPSS** | 0.14 | 0.11 | 147.22 | -1.25 | 0.89 | 0.11 |
| | | | ***None*** | | | |
| **PP** | 0.12 | -8.74 | -0.98* | -3.85 | 2.79* | -10.31 |

Fuente: Elaboración propia con base en los resultados del modelo. .Nota: * Ho: ∃ Raíz Unitaria al 95% .Todas las pruebas demuestran que las series son no estacionarias en niveles, y que el grado de integración es I (1).

Cuadro 2A
**Prueba de cointegración de Johansen.**

| No. Of Ce(S) | Eigenvalue | Estadistico De La Traza | Valor Crítico 0.05 | Prob. ** |
|---|---|---|---|---|
| **None *** | 0.538712 | 56.60391 | 29.79707 | 0 |
| **1** | 0.2291 | 14.82231 | 15.49471 | 0.063 |

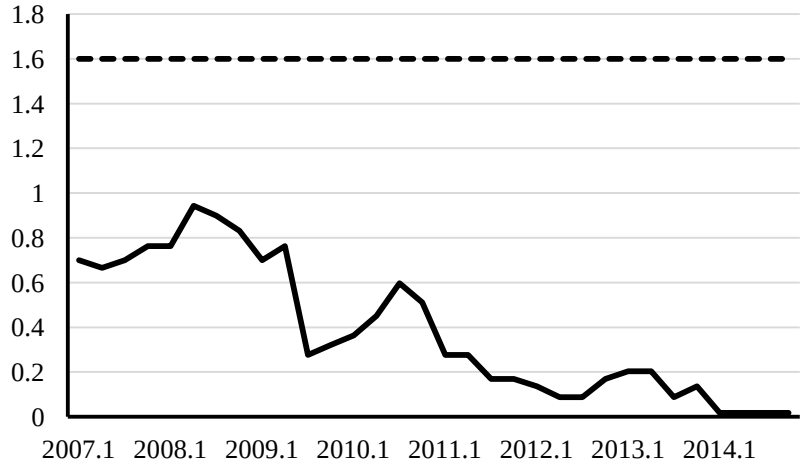
Fuente: Elaboración propia con base en los resultados del modelo.

Cuadro 3A
**Prueba de Max. Eigen Valor**

| No. Of Ce(S) | Eigenvalue | Estadistico Max. Eigen Valor | Valor Crítico 0.05 | Prob. ** |
|---|---|---|---|---|
| **None *** | 0.538712 | 41.7816 | 21.13162 | 0 |
| **1** | 0.2291 | 14.05064 | 14.2646 | 0.054 |

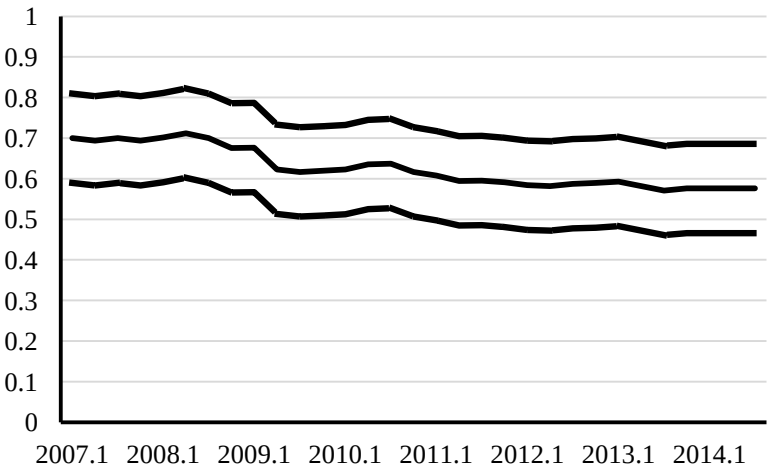
Fuente: Elaboración propia con base en los resultados del modelo.

Gráfica 1A
**Prueba de estabilidad y cambio estructural del Modelo**
**Prueba tau Ƭ**




Fuente: Elaboración propia con base en los resultados del modelo.

Gráfica 2A
**Eigen-valor recursivo**




Fuente: Elaboración propia con base en los resultados del modelo.

**Metodología de trimestralización aplicada a la PTF, 2000-2014**

El procedimiento de desagregación temporal Chow-Lin (1971) consiste en regresionar la variable objetivo $\boldsymbol{Y_a}$ de baja frecuencia, respecto al vector de variables auxiliares $\boldsymbol{X_a}$ de alta frecuencia:

$$Y_a = X_a\beta_b + V_aC'(CV_aC')^{-1}U_b$$

Donde la matriz $\boldsymbol{V_a}$ es una matriz que ponderará la regresión, y la matriz $\boldsymbol{C}$ es la matriz de paso que convierte los valores de baja frecuencia a alta frecuencia, lo que permite regresionar variables con diferentes frecuencias.
El vector $\boldsymbol{\beta_b}$ se calcula por medio de Mínimos Cuadrados Generalizados (MCG):

$$\beta_b = (X_a'C'(CV_aC')CX_a)^{-1}X_a'C'(CV_aC')^{-1}Y_b$$

La matriz $\boldsymbol{V_a}$ está definida por $\boldsymbol{V_a = (D'H'HD)^{-1}}$ (Litterman, 1983), donde $\boldsymbol{D}$ es la matriz de primeras diferencias, y $\boldsymbol{H}$ es la matriz que suaviza la desagregación de las series.

$$D = \begin{bmatrix} 1 & 0 & \cdots & 0 \\ -1 & 1 & & \\ \vdots & -1 & \ddots & \\ 0 & & -1 & 1 \end{bmatrix}$$

$$H = \begin{bmatrix} 1 & 0 & \cdots & 0 \\ \rho & 1 & & \\ \vdots & \rho & \ddots & 0 \\ 0 & & \rho & 1 \end{bmatrix}$$

Donde $\boldsymbol{\rho}$ es el parámetro que suaviza los valores calculados en la matriz H.

*Ensayos Revista de Economía- Volumen XXXV, núm.2, noviembre 2016, pp. 175-194*

# Modelación de las dinámicas, volatilidades e interrelaciones de los rendimientos del petróleo mexicano, BRENT y WTI

## *Modeling the Dynamics, Volatilities and Interrelations of the Mexican, Brent and WTI Oil Returns*

Antonio Ruiz-Porras[*]
Javier Emmanuel Anguiano Pita[**]

Fecha de recepción: 15 II 2016 Fecha de aceptación: 06 VI 2016

**Resumen**

Estudiamos las dinámicas, volatilidades e interrelaciones de los rendimientos del petróleo mexicano (MME), Brent y WTI con doce modelos GARCH multivariados. Los resultados sugieren que: 1) la volatilidad de la MME es mayor que la del WTI y menor que la del Brent; 2) el modelo AR(1)-TGARCH(1,1) con una distribución t-de-Student multivariada es el que mejor describe los rendimientos; 3) existen algunas interrelaciones entre las volatilidades de los rendimientos y 4) las buenas y malas noticias tienen impactos asimétricos sobre las volatilidades. El estudio usa datos diarios de los precios spot del petróleo y de sus rendimientos para el periodo 03/01/2000-11/02/2016.

***Clasificación JEL*****:** Q40; C32; C52.
***Palabras Clave****:* Rendimientos del petróleo. MME. Brent. WTI. Modelos GARCH Multivariados.

[*] Departamento de Métodos Cuantitativos. Universidad de Guadalajara, CUCEA. Dirección: Periférico Norte 799, Núcleo Universitario Los Belenes, 45100, Zapopan, Jalisco, México. Email: antoniop@cucea.udg.mx
[**] Universidad de Guadalajara, CUCEA. Dirección: Periférico Norte 799, Núcleo Universitario Los Belenes, 45100, Zapopan, Jalisco, México. Email: je.ptt@hotmail.com

Los autores agradecen al Sistema Geológico Mexicano/Secretaría de Economía por facilitarles las series usadas en este estudio. Asimismo, agradecen los comentarios de Raúl Alberto Ponce Rodríguez (UACJ) a la versión preliminar del mismo.

**Abstract**

We study the dynamics, volatilities and interrelations of the Mexican (MME), Brent and WTI oil returns with twelve multivariate GARCH models. The main results suggest that: 1) The volatility of MME is bigger than the one of the WTI, but smaller than the one of Brent. 2) The AR (1)-TGARCH (1,1) model with a multivariate t-Student distribution is the best one to describe the returns. 4) There are some interrelations among the volatilities of returns; and 4) good and bad news have asymmetric impacts on the volatilities. The study uses daily data of oil spot prices and their returns for the period 01/03/2000- 11/02/2016.

***JEL Classiffication:*** Q40; C32; C52.
***Keywords****:* Oil returns. MME. Brent. WTI. Multivariate GARCH models.

## Introducción

En la actualidad, el petróleo crudo es el recurso natural no renovable más importante en el mundo. El petróleo y sus derivados proveen energía, insumos y productos, vitales para las sociedades contemporáneas. En el nivel mundial, el petróleo es la fuente de energía más usada debido a su alta densidad energética, a su fácil transportación y a su relativa abundancia (Hilyard, 2012). La Organización de Países Productores de Petróleo (OPEC, por sus siglas en inglés) estima que el petróleo provee aproximadamente el 30 por ciento de la oferta mundial de energía primaria[1]. Además, el petróleo y sus derivados se usan extensamente en la industria, los transportes, los hogares y los productos petroquímicos.

La importancia económica del petróleo también es considerable para la economía global. El petróleo es el commodity más extenso y activamente comerciado en el mundo (Fan y Li, 2015). Solamente durante los años 2015 y 2016, la demanda mundial de petróleo ha sido estimada en 92.92 y 94.17 millones de barriles diarios (OPEC, 2016). Por esta razón, los precios y rendimientos petroleros son monitoreados constantemente por los agentes económicos y financieros y por los hacedores de políticas y los analistas. De hecho, hay quienes argumentan que las dinámicas del petróleo explican en buena medida el comportamiento de la economía global (Hamilton, 1983; Morck, 1989; Fan y Li, 2015).

La relevancia del petróleo ha promovido el desarrollo de estudios para describir y analizar los rendimientos del mismo (i.e., las tasas de variación de los precios). Estos estudios suelen justificarse argumentando que las volatilidades de los

[1] Las estimaciones de la contribución del petróleo a la oferta mundial de energía son, para los años 2010 y 2020, 31.9 y 29.6 por ciento, respectivamente (OPEC, 2014).

rendimientos inducen los siguientes efectos: 1) variaciones en la producción, los rendimientos bursátiles, las tasas de interés de los países consumidores y en los términos de intercambio[2]; 2) inestabilidad financiera en los países productores[3], 3) efectos negativos sobre la inversión y el crecimiento económico[4] y 4) discrepancias entre los niveles óptimos y observados en el uso y conservación de energía por parte de los consumidores y las industrias[5].

Las razones mencionadas justifican el estudio de los rendimientos del petróleo en la literatura. En México, dicho estudio se justifica, en añadidura a las mencionadas razones, porque los ingresos petroleros integran buena parte de las exportaciones totales del país[6]. Asimismo, se justifica porque dichos ingresos proveen más del 29.7 por ciento del total del presupuesto de gasto público (SHCP, 2015). En este contexto, puede explicarse porque los indicadores del mercado de petróleo spot[7], junto con los cambiarios y los monetarios, son los más monitoreados en el país. Asimismo, puede explicarse porque la Reforma Energética fue la primera reforma estructural promulgada en este decenio (20 de diciembre de 2013).

Econométricamente, muchos esfuerzos han sido desarrollados para describir y analizar las series de rendimientos del petróleo. Estos esfuerzos se explican porque las mencionadas series tienen comportamientos muy complejos de modelar, mediante técnicas tradicionales (véase Fattouh, 2007; Bashiri-Behmiri y Manso, 2013; Fan y Li, 2015). Las mencionadas series suelen manifestar comportamientos no lineales, clusters de volatilidad, volatilidades no constantes, shocks informacionales asimétricos, curtosis excesivas y distribuciones no normales. Por estas razones, los modelos de series de tiempo de la familia

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[2] Hamilton (1983), Sadorsky (1999), Papapetrou (2001) y Backus y Crucini (2000) muestran los efectos que tiene la volatilidad del petróleo, respectivamente, sobre la producción agregada, los rendimientos bursátiles, las tasas de interés y los términos de intercambio. En el contexto latinoamericano, destacan los estudios de Sánchez-Albavera y Vargas (2005) y Lorenzo-Valdés, Durán-Vázquez y Armenta-Fraire (2012).

[3] Iranzo (1993) explica que las caídas de los ingresos petroleros de los países productores durante 1959 y 1960 promovieron las reuniones que culminaron con la creación de la OPEC a finales de 1960. Más aún, este autor explicita que la OPEC se constituyó "teniendo como objetivo fundamental lograr la estabilización de los precios del petróleo" (Iranzo, 1993: 212).

[4] Ferderer (1996) y Guo y Kliesen (2005) indican que la volatilidad del petróleo introduce incertidumbre, retrasa la inversión e induce reasignaciones costosas de recursos entre los sectores de la economía.

[5] Véase Regnier (2007) para una explicación detallada de las vinculaciones entre la volatilidad de los precios del petróleo y la conservación de los energéticos.

[6] En los años 2014 y 2015, las exportaciones petroleras contribuyeron, respectivamente, con el 9 y 6 por ciento del total de exportaciones. Así, las exportaciones petroleras equivalieron a 36,049 y 23,432 millones de dólares.

[7] Los precios y rendimientos del mercado spot son aquellos vinculados a contratos que son comprados o vendidos en un plazo de tiempo muy corto y que se hacen efectivos de modo inmediato.

ARCH/GARCH se han utilizado con frecuencia para analizar y describir dichas series[8].

Estadísticamente, la gran mayoría de los modelos ARCH/GARCH usados en la modelación de las series del petróleo son de tipo univariado. Son modelos que asumen que las dinámicas de las series de los distintos tipos de petróleo no tienen relación entre sí. Por tanto, no permiten analizar las potenciales interrelaciones entre las volatilidades de los distintos tipos de crudo que coexisten en el mercado. Particularmente, si se asume que la Mezcla Mexicana de Exportación (MME) es un sustituto cercano de otros tipos de petróleo que se comercian en los mercados internacionales; el uso de modelos univariados podría restringir el entendimiento de las dinámicas de las series mexicanas.

En este artículo se analizan y describen las dinámicas, volatilidades e interrelaciones de los rendimientos del petróleo mexicano y de los tipos de petróleo usados como referencia en el mercado global spot. Particularmente, se usan doce modelos GARCH multivariados con fines de modelación de las series de rendimientos del petróleo. La investigación se complementa con estadísticas descriptivas, pruebas de raíz unitaria y pruebas de efectos ARCH. La muestra incluye los precios spot de cierre diarios del barril de petróleo de los tipos mexicano (MME), del Mar del Norte (Brent) y Western Texas Intermediate (WTI), para el periodo del 03 de enero de 2000 al 11 de febrero de 2016.

La investigación complementa a la literatura referida a la modelación y análisis de los rendimientos del petróleo, desde una perspectiva multivariada. Particularmente, aquí se modelan las dinámicas, las volatilidades y las interrelaciones entre los rendimientos de los tres tipos de petróleo mencionados. Si bien existen estudios que analizan las interrelaciones de los rendimientos del petróleo mexicano con algunas variables económicas y financieras; aquí, se enfatizan sus interrelaciones con los tipos de petróleo de referencia usados en el mercado global. Además, los modelos se usan para estudiar las distribuciones de las perturbaciones y los efectos de "shocks informacionales" sobre la volatilidad de las series.

El artículo está organizado en cinco secciones. La sección 1 caracteriza el mercado global del petróleo y revisa la literatura referida a la modelación de los rendimientos del petróleo. La sección 2 explica la metodología de análisis. La sección 3 describe la base de datos e incluye el análisis estadístico; esta sección incluye las estadísticas descriptivas, las pruebas de raíz unitaria y las pruebas de efectos ARCH. La sección 4 incluye los ejercicios de modelación y análisis de

[8] Los modelos de la familia ARCH/GARCH suponen una estructura dinámica autorregresiva de la varianza condicional de las series. En este contexto, no sobra señalar que ARCH y GARCH son acrónimos, respectivamente, de "*Autoregressive Conditional Heteroscedasticity"* y "*Generalized Autoregressive Conditional Heteroscedasticity"*.

las series, también las estimaciones de los modelos GARCH multivariados, el análisis de las series y una estimación de las varianzas y covarianzas condicionales. La sección 5 sintetiza y discute los resultados.

## 1. El mercado global de petróleo y la modelación de series

El mercado global de petróleo es un mercado monopolístico donde existen productos diferenciados. Esta situación explica por qué se manejan diversos contratos, precios y rendimientos del petróleo. En este contexto, algunos de los principales determinantes de los precios son las características físico-químicas de los tipos de petróleo[9]. Las características mencionadas se refieren a su densidad y a su contenido de azufre. Particularmente, los precios spot de los tipos de petróleo WTI y Brent, ligeros y con bajo contenido de azufre, se usan para establecer los precios de los otros tipos de petróleo[10]. Por esta razón, los precios y rendimientos del WTI y el Brent se consideran como referencias del mercado global[11].

La mezcla mexicana de exportación (MME) es una canasta compuesta por tres tipos de petróleo diferentes. De acuerdo con el Instituto Mexicano del Petróleo (IMP, 2014), el tipo de petróleo Maya constituye cerca de la mitad del total de la canasta de producción y está clasificado en la categoría de tipo de petróleo pesado, con alto contenido de azufre. El tipo de petróleo Istmo constituye cerca de un tercio de la canasta de producción y está clasificado en la categoría de ligero, con bajo contenido de azufre. Por último, el tipo de petróleo Olmeca constituye aproximadamente un quinto del total de la canasta de producción y está clasificado en la categoría de extra ligero, con bajo contenido de azufre.

La naturaleza monopolística del mercado global induce que haya comportamientos dinámicos en los precios y rendimientos de los distintos tipos de petróleo. Estos comportamientos no son necesariamente iguales ni están completamente sincronizados entre sí, porque los tipos de petróleo no son sustitutos perfectos. Las similitudes y diferencias de los comportamientos son particularmente notorias en las series de rendimientos diarios de los tres tipos de petróleo analizados. De hecho, las gráficas de las series muestran la existencia de

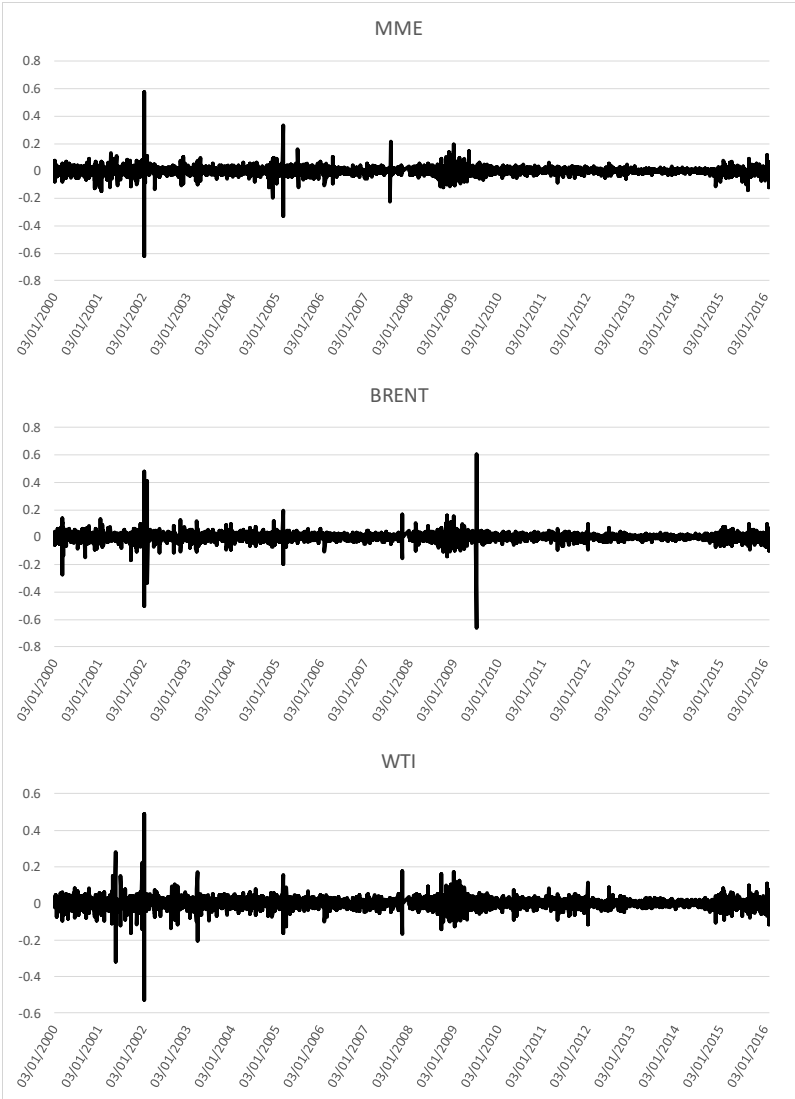
[9] Entre los determinantes de los precios del petróleo que no están vinculados a sus características físico-químicas, sobresalen los desequilibrios de oferta y demanda de mercado, las tensiones geopolíticas, los ciclos económicos internacionales y los mercados financieros. Los precios spot suelen ser muy sensibles ante estos determinantes.

[10] Los tipos de petróleo WTI y Brent establecen, respectivamente, los precios de referencia en Estados Unidos y Europa. Particularmente, el petróleo WTI resulta más ligero y tiene un menor contenido de azufre que el Brent (i.e., el WTI tiene una calidad mayor que el Brent).

[11] Debe señalarse que existen algunos precios de referencia alternativos. Entre estos se encuentran los precios del crudo de Dubai y de la canasta de referencia de la OPEC.

clusters de volatilidad, volatilidades no constantes y movimientos conjuntos de medias y varianzas (véase figura 1).

Figura 1
**Rendimientos diarios de los tipos de petróleo MME, Brent y WYI del 04 de enero de 2000 al 11 de febrero de 2016**




Nota: estimaciones propias.

Es interesante señalar que los modelos MGARCH no se han usado para estudiar las interrelaciones del petróleo spot mexicano con sus contrapartes internacionales[12]. Los estudios que analizan la volatilidad histórica de los rendimientos mexicanos suelen usar modelos ARCH/GARCH univariados. Entre estos estudios se incluyen los de Dávila-Pérez, Núñez-Mora y Ruiz-Porras (2006), López-Sarabia y Venegas-Martínez (2010), De Jesús-Gutiérrez y Carvajal-Gutiérrez (2013), De Jesús-Gutiérrez, Vergara-González y Diaz-Carreño (2015). Usualmente, dichos estudios hallan que los rendimientos tienen estructuras autorregresivas y que existen efectos informacionales asimétricos sobre la volatilidad[13].

Finalmente, no sobra señalar que entender las dinámicas, volatilidades e interrelaciones de los tipos de petróleo MME, Brent y WTI es pertinente por razones económicas y financieras. Las principales razones se vinculan a entender: 1) El grado de competencia monopolística en el mercado global del petróleo; 2) los mecanismos de transmisión de las volatilidades de corto plazo en los mercados internacionales; 3) los impactos de shocks informacionales sobre las volatilidades y 4) el diseño de instrumentos de cobertura y de estrategias de administración de riesgos. Por todas estas razones, puede argumentarse que la pertinencia del estudio aquí planteado queda plenamente justificada.

## 2. Metodología de análisis

En esta sección, se describe la metodología usada para modelar y analizar los rendimientos de los tipos de petróleo MME, Brent y WTI. Esta metodología refiere tanto al análisis estadístico de las series de tiempo como al ejercicio de modelación y análisis de las series. En este contexto, debe señalarse que las series de tiempo usadas aquí se estiman con los precios de cierre de cada tipo de petróleo *i* en el día *t*, $P_{it}$. Por convención, las series de precios se expresan en términos de logaritmos. Asimismo, los rendimientos diarios del tipo de petróleo *i* en el día *t*, $r_{it}$, se definen con base en la siguiente expresión:

[12] Cabe señalar que los modelos MGARCH se han usado para modelar las interrelaciones de los precios futuros del petróleo Istmo y Maya con el WTI. Véase el trabajo de De-Jesús-Gutiérrez (2016).

[13] Dávila-Pérez, Núñez-Mora y Ruiz-Porras (2006) analizan la dinámica de la volatilidad del precio de la MME mediante la estimación de un modelo GARCH (1,1) simétrico. López-Sarabia y Venegas-Martínez (2010) analizan la eficiencia de las coberturas mexicanas usando un modelo simétrico para pronosticar la volatilidad del precio de la MME. De-Jesús -Gutiérrez y Carvajal-Gutiérrez (2013) estudian la dinámica de los rendimientos de la MME y del Maya mediante cuatro modelos de la familia ARCH/GARCH. De-Jesús-Gutiérrez, Vergara-González y Díaz-Carreño (2015) usan varios modelos de la misma familia para pronosticar la volatilidad de los rendimientos de la MME.

$$r_{it} = \ln P_{it} - \ln P_{it-1} \quad (1)$$

El análisis estadístico usa estadísticas descriptivas y pruebas de raíz unitaria y de efectos ARCH para estudiar las series de rendimientos. Particularmente, las estadísticas descriptivas se usan para caracterizar las series de rendimientos. La prueba de raíz unitaria, Aumentada de Dickey-Fuller (ADF), se usa para analizar el orden de integración de las series. La hipótesis nula de dicha prueba es que existen raíces unitarias. En este contexto, cabe señalar que las series deben ser ser estacionarias para evitar modelaciones espurias. La prueba ARCH-LM se usa para evaluar la existencia de efectos ARCH. La hipótesis nula de la prueba es que no existen efectos ARCH (Engle, 1982)[14].

Los ejercicios de modelación y análisis de las series de rendimientos se sustentan en doce modelos GARCH multivariados. Los modelos usados aquí son de los tipos DVECH (*Diagonal VECH*), DBEKK (*Diagonal BEKK*) y CCC (*Constant Conditional Correlation*)[15]. Estos modelos se estiman considerando diferentes especificaciones dinámicas y distribuciones de densidad. Particularmente, aquí se usan especificaciones de tipo GARCH (*Generalized ARCH*) y TGARCH (*Threshold GARCH*) para evaluar los impactos de "shocks informacionales" sobre la volatilidad de las series[16]. Las distribuciones de densidad multivariada se usan para describir el comportamiento de las perturbaciones.

Matemáticamente, la estructura dinámica de cada uno de los modelos GARCH multivariados, usados aquí, se define como como un sistema de ecuaciones matriciales. Las tres expresiones que integran la estructura de cada modelo son las siguientes:

$$r_{it} = \phi_{i0} + \phi_{i1} r_{it-1} + \varepsilon_{it} \quad (2)$$

$$\varepsilon_t = H^{\frac{1}{2}}(\theta) z_t \quad (3)$$

[14] Las pruebas ARCH-LM usadas aquí se basan en la metodología propuesta por Brooks (2008).

[15] Véase los trabajos de Bollerslev, Engle y Wooldridge (1988), Engle y Kroner (1995) y Bollerslev (1990) para una introducción a los modelos DVECH, DBEKK y CCC.

[16] Los "shocks informacionales" son los impactos de las noticias, i.e., las perturbaciones rezagadas sobre la volatilidad de las series. Estos impactos pueden clasificarse como simétricos o asimétricos. La especificación GARCH asume que las buenas y malas noticias tienen impactos de similar magnitud sobre la volatilidad (i.e., impactos simétricos). La especificación TGARCH asume que las buenas y malas noticias pueden tener impactos de magnitud diferenciada (i.e., impactos asimétricos). Véase los estudios de Bollerslev (1986) y Zakoian (1994), respectivamente, para una descripción matemática de las especificaciones GARCH y TGARCH.

$$VarCov\left(r_t \middle| I_{t-1}\right) = H^{\frac{1}{2}} Var_{t-1}\left(z_t\right)\left(H^{\frac{1}{2}}\right)' = H_t \qquad (4)$$

donde $r_t$ es un vector que incluye una serie de tiempo multivariada de N procesos estocásticos; $\theta$ es un vector de coeficientes; $H^{1/2}(\theta)$ es una matriz definida positiva *NxN*; y $z_t$ es un vector aleatorio *Nx1*, tal que $E(z_t)=0$ y $Var(z_t)=I_N$

Los modelos GARCH multivariados permiten modelar y analizar las volatilidades e interrelaciones con base en ciertos supuestos sobre: 1) la matriz de varianza-covarianza condicionada, $H_t$; 2) la especificación del impacto de los shocks informacionales y 3) la distribución de densidad multivariada. Particularmente, los supuestos sobre las matrices de varianza-covarianza condicionada incluyen aquellos que definen a los modelos DVECH, DBEKK y CCC[17]. Los supuestos sobre los impactos de shocks informacionales incluyen aquellos que definen a las especificaciones GARCH y TGARCH. Las distribuciones asumidas incluyen a la normal y *t* de Student multivariadas.

Las modelación y análisis de las volatilidades e interrelaciones de las series del petróleo mediante los modelos MGARCH se realizan considerando que: 1) las estimaciones se obtienen iterativamente mediante el método de Máxima Verosimilitud; 2) las matrices de varianza-covarianza deben ser positivas semi-definidas y 3) las perturbaciones siguen procesos autorregresivos AR(1). Particularmente, aquí se evalúa si las matrices de varianza-covarianza son positivas semi-definidas con fines de validación de las estimaciones. Asimismo, se formaliza el supuesto autorregresivo definiendo la perturbación, $\varepsilon_{it}$, como: $\varepsilon_{it} = c + \rho\, \varepsilon_{it-1} + v$; donde $c$ es una constante y $v_{it}$ es ruido blanco.

El ejercicio de modelación de las dinámicas, volatilidades e interrelaciones de las series de rendimientos se sustenta en los doce modelos GARCH multivariados que aquí se usan. El análisis de series se centra en la evaluación de la significancia estadística de: 1) $\rho$, $\phi_{i0}$ y $\phi_{i1}$, los coeficientes de las expresiones de las medias; 2) los coeficientes de las matrices de varianza-covarianza y 3) el coeficiente de la distribución *t* de Student multivariada. En todos los casos, se utilizan los *p-values* asociados a los estadísticos de significancia individual de coeficientes con fines de análisis. El nivel de significancia usado para evaluar las pruebas de hipótesis es del diez por ciento.

[17] Una descripción de los supuestos estadísticos de las matrices de varianza-covarianza que definen a los modelos MGARCH usados en esta investigación se encuentra en Minovic (2009). Sin embargo, debe señalarse que aquí se adoptaron algunos supuestos adicionales para estimar los modelos MGARCH. Estos supuestos son los siguientes: 1) Para los modelos DVECH se asume una matriz indefinida de constantes; 2) para los modelos CCC se asumen constantes escalares y 3) para los modelos DBEEK se asume una matriz diagonal de constantes.

Finalmente, debe señalarse que el análisis de la bondad de ajuste de los modelos GARCH multivariados se sustenta en el criterio de información de Akaike (*AIC*). Se usa este criterio, en virtud de que el mismo permite seleccionar de manera unívoca el modelo que mejor describe la dinámica de un grupo de series, cuando se comparan estimaciones de modelos que pueden ser no anidados (Burnham y Anderson, 2002). Asimismo, se usa este criterio porque permite determinar, de una manera sencilla, las principales características que definen las dinámicas, volatilidades e interrelaciones de las series de rendimientos de los tipos de petróleo MME, Brent y WTI.

## 3. Base de datos y análisis estadístico

La base de datos usada en esta investigación utiliza una muestra de precios del petróleo de los tipos MME, Brent y WTI compilada por el Servicio Geológico Mexicano/Secretaria de Economía. La muestra incluye los precios de cierre diarios spot del barril de petróleo de los tres tipos mencionados, para el periodo del 03 de enero de 2000 al 11 de febrero de 2016. Todos los precios están expresados nominalmente en dólares estadounidenses. Por conveniencia estadística, las series de rendimientos son estimadas con base en la ecuación (1). Así, la muestra se integra con tres series de precios y tres de rendimientos. Particularmente, las series de rendimientos incluyen 4066 observaciones diarias.

Tabla 1
**Estadística descriptiva de las series de rendimientos diarios y pruebas de normalidad de Jarque-Bera**

| | MME | Brent | WTI |
|---|---|---|---|
| **Promedio** | 0.0000 | 0.0000 | 0.0000 |
| **Desv. Est.** | 0.0000 | 0.0000 | 0.0000 |
| **Mediana** | 0.0000 | 0.0001 | 0.0002 |
| **Mínimo** | -0.6219 | -0.6626 | -0.5295 |
| **Máximo** | 0.5784 | 0.6055 | 0.4885 |
| **Coef. Asim.** | -0.5608 | -0.6205 | -0.4363 |
| **Curtosis** | 98.3072 | 114.4394 | 54.8011 |
| **Jarque-Bera** | 1539102.00 | 2104203.00 | 454733.10 |
| **P-value** | 0.000 | 0.000 | 0.000 |
| **Observaciones** | 4066 | 4066 | 4066 |

Nota: los valores de las series son expresados en términos de las primeras diferencias de las series en logaritmos. Fuente: estimaciones propias

La tabla 1 presenta la estadística descriptiva y los estadísticos Jarque-Bera estimados para las series de rendimientos del petróleo. Particularmente, la tabla

muestra que las medias de las series de rendimientos, a su vez, muestran valores similares. En la tabla también se observa que la volatilidad de la MME es mayor que la del WTI y menor que la del Brent[18]. Además, las estimaciones permiten ver que las series de rendimientos tienen curtosis excesivas, sesgos negativos y distribuciones no normales. Estas características son importantes porque complementan a aquellas halladas previamente (i.e., clusters de volatilidad, volatilidades no constantes y movimientos conjuntos de medias y varianzas).

Tabla 2
**Pruebas ADF de las series en niveles y en primeras diferencias**

| Serie | Niveles | | Diferencias | | I(d) |
|---|---|---|---|---|---|
| | P-value | Rezagos | P-value | Rezagos | |
| MME | 0.9943 | 1 | 0.0001 | 0 | 1 |
| Brent | 0.9940 | 2 | 0.0000 | 1 | 1 |
| WTI | 0.9910 | 2 | 0.0000 | 1 | 1 |

Nota: la hipótesis nula de la prueba ADF es que hay raíz unitaria. Las pruebas incluyen una tendencia lineal e intercepto como regresores externos. El número de rezagos se estima con base en el criterio de información de Schwarz. El criterio de decisión supone un nivel de significancia del 5%. Las series en niveles son aquellas de los valores expresados en términos de logaritmos. Las series de diferencias son aquellas de los valores de rendimientos diarios.

Las tablas 2 y 3 sugieren que las series de rendimientos de los tres tipos de petróleo son susceptibles de ser analizadas mediante modelos GARCH multivariados. Particularmente, en la tabla 2, se observa que las series de rendimientos son estacionarias, I(0). La tabla 3, por su parte, muestra que en las series de rendimientos no se puede rechazar la hipótesis nula, que no existen efectos ARCH. Así, los resultados implican que únicamente las series de rendimientos cumplen los requisitos estadísticos para analizarse mediante modelos de la familia ARCH/GARCH. Por tanto, los resultados implican que se obtendrían estimaciones espurias de modelar los precios del petróleo.

Finalmente, los principales hallazgos del análisis estadístico pueden sintetizarse de la siguiente manera: 1) las medias de las tres series de rendimientos muestran valores similares y positivos; 2) la volatilidad de los rendimientos de la MME es mayor que la del WTI y menor que la del Brent; 3) los rendimientos tienden a manifestar curtosis excesivas, clusters de volatilidad, asimetrías, distribuciones no normales, volatilidades no constantes y movimientos conjuntos de medias y varianzas y 4) únicamente las series de rendimientos cumplen los requisitos para

[18] Esta conclusión se deduce indirectamente, a través de los valores de la curtosis. Sin embargo, cabe destacar que se hicieron algunos ejercicios alternativos para otros periodos y la conclusión se mantiene. Incluso, los valores estimados de la desviación estándar son positivos en un nivel de diezmilésimos.

modelarse mediante modelos de la familia ARCH/GARCH (i.e., las series son estacionarias y manifiestan efectos ARCH).

Tabla 3
**Prueba de efectos ARCH-LM para la serie de rendimientos**

| Serie | Estadístico F | P-value |
|---|---|---|
| MME | 396.9150 | 0.0000 |
| Brent | 142.6604 | 0.0000 |
| WTI | 355.6302 | 0.0000 |

Nota: la prueba fue realizada considerando 5 rezagos. La hipótesis nula de la prueba es que no hay efectos ARCH. El criterio de decisión supone un nivel de significancia del 5%. Fuente: Estimaciones propias.

## 4. Ejercicios de modelación y análisis de las series

En esta sección se modelan las dinámicas, volatilidades e interrelaciones de las series de rendimientos de los tipos de petróleo MME, Brent y WTI. Asimismo, se hace el análisis de los doce modelos GARCH multivariados estimados. Particularmente, las estimaciones de los modelos se sintetizan en la tabla 4. Por simplicidad, en dicha tabla se indican los números de coeficientes estimados y significativos de las especificaciones de la media y varianza de cada modelo[19]. La tabla 5, por su parte, muestra las estimaciones del Criterio de Información de Akaike vinculadas a cada modelo. La importancia de dichas estimaciones es que permiten determinar la relativa bondad de ajuste de los modelos.

La tabla 4 muestra las estimaciones de los doce modelos multivariados que describen el conjunto de series de los rendimientos del petróleo. Estas estimaciones proveen elementos para entender las dinámicas, volatilidades e interrelaciones de las series. Particularmente, la tabla muestra que los rendimientos tienden a estar correlacionados en el tiempo: las estimaciones de $\rho$ y de los coeficientes de las matrices de varianza-covarianza son en su mayoría significativas. Las estimaciones de $\rho$ muestran, además, que existen relaciones comunes en la dinámica de la media de las tres series (dado que se asumen términos autorregresivos comunes).

[19] Los coeficientes estimados de la matriz de varianza-covarianza, $H_t$, se muestran en forma "bruta" y "transformada". La ventaja de presentar los coeficientes estimados en forma transformada es que hace explícito que puede haber coeficientes de las matrices que integran a $H_t$, que son el resultado de funciones asociadas a los coeficientes en forma bruta. Por tanto, bajo ciertas circunstancias, puede ocurrir que no exista una correspondencia uno-a-uno entre los coeficientes presentados en ambas formas.

Tabla 4
**Modelos MGARCH estimados para las series de rendimientos diarios**

| Especificación Dinámica | Modelo | Parámetros | AR(1)-GARCH(1,1) Normal | AR(1)-TGARCH(1,1) Normal | AR(1)-GARCH(1,1) t-Student | AR(1)-TGARCH(1,1) t-Student |
|---|---|---|---|---|---|---|
| Media | DVECH | ρ | *-0.1573* *** | *-0.1345* *** | *-0.2061* *** | *-0.2061* *** |
| | | Estimados | 4 | 4 | 4 | 4 |
| | | Significativos | 3 | 2 | 1 | 1 |
| | CCC | ρ | *-0.1667* *** | *-0.1633* *** | *-0.1161* *** | *-0.1147* *** |
| | | Estimados | 4 | 4 | 4 | 4 |
| | | Significativos | 2 | 2 | 4 | 4 |
| | DBEKK | ρ | *-0.1729* *** | *-0.1584* *** | *-0.1231* *** | *-0.1197* *** |
| | | Estimados | 4 | 4 | 4 | 4 |
| | | Significativos | 2 | 2 | 4 | 4 |
| Varianza | DVECH | Estimados | 18 | 24 | 18 | 24 |
| | | Significativos | 18 | 24 | 15 | 23 |
| | CCC | Estimados | 12 | 15 | 12 | 15 |
| | | Significativos | 12 | 15 | 12 | 15 |
| | DBEKK | Estimados | 9 | 12 | 9 | 12 |
| | | Significativos | 9 | 12 | 9 | 12 |
| Distribución t | DVECH | Estimados | | 1 | 1 | 1 |
| | | Significativos | | 1 | 1 | 1 |
| | CCC | Estimados | | | 1 | 1 |
| | | Significativos | | | 1 | 1 |
| | DBEKK | Estimados | | | 1 | 1 |
| | | Significativos | | | 1 | 1 |
| Varianza Transformada | DVECH | Estimados | 18 | 24 | 18 | 24 |
| | | Significativos | 18 | 24 | 15 | 15 |
| | CCC | Estimados | 12 | 15 | 12 | 15 |
| | | Significativos | 12 | 15 | 12 | 15 |
| | DBEKK | Estimados | 9 | 12 | 9 | 12 |
| | | Significativos | 9 | 12 | 9 | 12 |

Nota: el coeficiente del término autorregresivo se reporta en negritas e itálicas. Se reporta el número de parámetros estimados significativos de cada una de las especificaciones de los modelos. Se considera un nivel de significancia del 10 por ciento para determinar los parámetros significativos. Uno, dos y tres asteriscos denotan niveles de significancia del 10, 5 y 1 por ciento.

La tabla 5 permite comparar las estimaciones de bondad de ajuste de los modelos. Estas estimaciones son importantes porque sugieren que los modelos DBEKK y las especificaciones TGARCH tienen una mejor bondad de ajuste. Asimismo, sugieren que las perturbaciones no siguen una distribución normal multivariada. Así, las estimaciones indican que el modelo AR(1)-DBEKK-TGARCH(1,1) con una distribución t-de-Student multivariada es el que mejor describe las series de rendimientos[20]. Por esta razón, las varianzas y covarianzas

[20] La tabla 4 también valida que las series de rendimientos pueden ser descritas por dicho modelo. De hecho, la totalidad de coeficientes estimados son significativos (17 de 17). Estos

estimadas con este modelo se grafican en la figura 2; esto con fines de ilustrar las volatilidades e interrelaciones entre los tres tipos de petróleo.

Tabla 5
**Estimaciones de bondad de ajuste de los modelos MGARCH.**

| Modelo | Criterio de Información de Akaike | | | | | Modelo con mejor bondad de ajuste |
|---|---|---|---|---|---|---|
| | DVECH | | CCC | DBEKK | | |
| AR(1)-GARCH(1,1) | -15.168 | * | -14.9355 | -15.0982 | * | CCC |
| AR(1)-TGARCH(1,1) | -15.200 | * | -14.9447 | -15.1292 | * | CCC |
| AR(1)-GARCH(1,1) t Student | -16.093 | * | -16.5093 | -16.7104 | | DBEKK |
| AR(1)-TGARCH(1,1) t Student | -16.090 | * | -16.5120 | -16.7291 | | *DBEKK* |

Nota: un asterisco denota que los modelos estimados no cumplen con la condición de que la matriz de varianza-covarianza sea definida como positiva. Se identifica con itálicas y negritas al modelo con mejor bondad de ajuste de cada grupo de series. Fuente: estimaciones propias.

La consistencia de los resultados sugiere que hay algunos patrones que definen el comportamiento dinámico de las series de rendimientos del petróleo. Particularmente, la predominancia de los modelos de tipo DBEEK sugiere que hay algunas interrelaciones entre las volatilidades de las series analizadas en el mercado global[21]. La predominancia de la especificación TGARCH sugiere que las buenas y malas noticias tienen impactos asimétricos sobre la volatilidad de los rendimientos. Además, la predominancia de la distribución *t* de Student multivariada valida que las perturbaciones no se distribuyen normalmente.

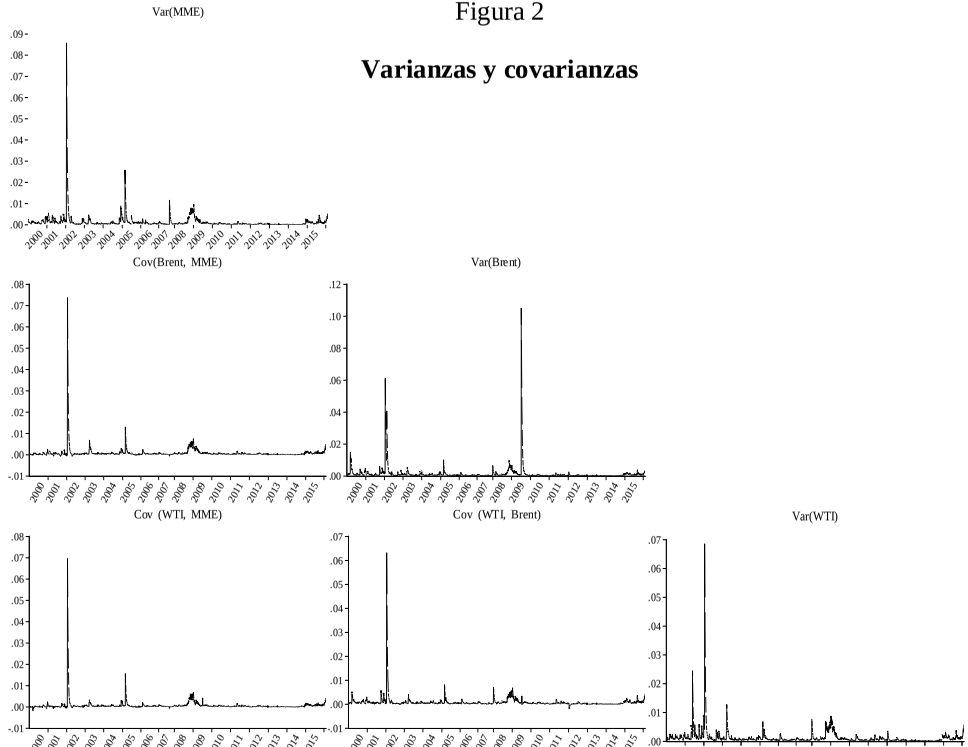
Finalmente, los resultados del ejercicio de modelación y análisis econométricos pueden sintetizarse de la siguiente manera: 1) El modelo AR(1)-DBEKK-TGARCH(1,1) es el que mejor describe la dinámica conjunta de los rendimientos del petróleo de los tipos MME, Brent y WTI; 2) existen relaciones comunes en la dinámica de la media de las tres series; 3) hay algunas interrelaciones entre las volatilidades de los rendimientos; 4) las buenas y malas noticias tienen impactos asimétricos sobre la volatilidad de los rendimientos y 5) la distribución *t* de Student multivariada describe de mejor manera a las perturbaciones de los modelos.

coeficientes incluyen los correspondientes a las especificaciones de la media, de la matriz de varianza-covarianza transformada y de la distribución de densidad.

[21] Los coeficientes de los modelos DBEKK son estimados asumiendo matrices de varianza-covarianza diagonales. Bajo este supuesto, las estimaciones de dichas matrices no consideran la existencia de interrelaciones entre las volatilidades de las series. Sin embargo, debe señalarse que la figura 2 sugiere que dichas interrelaciones pudieran existir al menos durante periodos cortos de tiempo.

Figura 2

**Varianzas y covarianzas**




Fuente: estimaciones propias. Varianzas y covarianzas condicionadas estimadas mediante el modelo AR(1)-DBEKK-TGARCH(1,1) con una distribución t-de-Student multivariada.

## Conclusiones y discusión

En esta investigación se han estudiado las dinámicas, volatilidades e interrelaciones de los rendimientos del petróleo mexicano, Brent y WTI usando doce modelos GARCH multivariados. Sus principales resultados han sido los siguientes: 1) la volatilidad de la MME es mayor que la del WTI y menor que la del Brent; 2) el modelo AR(1)-TGARCH(1,1) con una distribución t-de-Student multivariada es el que mejor describe la dinámica conjunta de los rendimientos del petróleo; 3) hay algunas interrelaciones entre las volatilidades de los rendimientos y 4) las buenas y malas noticias tienen impactos asimétricos sobre las volatilidades. El estudio ha usado datos diarios de los precios spot del petróleo y de sus rendimientos entre el 03 de enero de 2000 al 11 de febrero de 2016.

El estudio tiene implicaciones económicas y financieras para México. La más importante se refiere a la necesidad de replantear la planeación, los objetivos y las estrategias de política económica. Actualmente, la SHCP fija los Criterios de Política Económica usando estimaciones anuales de los precios de la MME (y de otras variables). Sin embargo, los hallazgos implican que sería mejor usar estimaciones de los rendimientos. Además, implican que las estimaciones de los precios serían adecuadas solo por coincidencia o por factores no observables[22]. Por estas razones, podría argumentarse que la propuesta coadyuvaría a mejorar la planeación y el desempeño de la economía mexicana.

Los hallazgos del estudio también tienen implicaciones para el desarrollo de investigación en los mercados internacionales de petróleo. La existencia de algunas interrelaciones entre las volatilidades sugiere que las volatilidades tienen origen al interior de los mercados y que hay "efectos contagio", entre ellos. Esta situación tiene implicaciones directas sobre las prácticas de administración de riesgos y, en particular, sobre las de cobertura. Los hallazgos validan la hipótesis de que sería posible mejorar las mencionadas prácticas usando modelos GARCH multivariados; incluso, validan la conveniencia de desarrollar más investigaciones sobre el tema[23].

Los hallazgos del estudio también tienen implicaciones adicionales para entender el comportamiento de los rendimientos del petróleo. Los "efectos apalancamiento" y la existencia de distribuciones no normales implican que las dinámicas y las volatilidades de los rendimientos son complejas. Intuitivamente,

[22] Esta situación podría explicar las diferencias entre los promedios de precios estimados y los reales. En los Criterios Generales de Política Económica 2013, 2014 y 2015, los precios estimados de la MME para dichos años fueron, respectivamente, 84.9, 81.0 y 82.0 dólares por barril. Los precios reales fueron, respectivamente, 98.70, 87.70 y 44.20 dólares por barril.

[23] El estudio de De-Jesús-Gutiérrez (2016) es un ejemplo reciente de este tipo de investigación.

la presencia de "efectos apalancamiento" indica que los impactos informacionales de las malas noticias sobre la volatilidad son mayores que los impactos de las buenas noticias. Además, la existencia de distribuciones no normales implica que los modelos de administración de riesgos tradicionales (i.e., Black-Scholes) podrían valuar los riesgos de manera inadecuada.

Finalmente, debe enfatizarse que la investigación referida a las dinámicas y volatilidades e interrelaciones del petróleo tiene amplias posibilidades de desarrollo. El petróleo es una variable clave en la economía. Particularmente, la importancia de este tipo de investigación se vincula directamente con las políticas económicas, las finanzas públicas, las prácticas de administración de riesgos y el desarrollo económico del país. Asimismo, se vincula con la necesidad de mejorar las metodologías de modelación, el análisis y el pronóstico de las series del petróleo. Por estas razones, la importancia de realizar nuevas investigaciones sobre el tema queda plenamente justificada.

## Referencias

Backus, D., y Crucini, M. (2000). "Oil prices and the terms of trade". *Journal of International Economics*, 50, 185-213.

Bashiri-Behmiri, N. y Pires-Manso, J.R. (2013). "Crude oil forecasting techniques: A comprehensive review of literature". *Alternative Investment Analysis Review*, 2(3), 30-49.

Bollerslev, T. (1986). "Generalized autoregressive conditional heteroskedasticity". *Journal of Econometrics*, 31(3), 307-327.

Bollerslev, T. (1990). "Modeling the coherence in short-run nominal exchange rates: A multivariate generalized ARCH model". *Review of Economics and Statistics*, 72(3), 498-505.

Bollerslev, T., Engle, R.F. y Wooldridge, J.M. (1988). "A capital asset pricing model with time-varying covariances". *Journal of Political Economy*, 96(1), 116-131.

Brooks, C. (2008). *Introductory Econometrics for Finance*, Segunda edición, Cambridge, UK: Cambridge University Press.

Burnham, K. P. y Anderson, D.R. (2002). *Model Selection and Multimodel Inference: A Practical Information-Theoretic Approach*, Segunda edición, Nueva York, US: Springer-Verlag.

Dávila-Pérez, J., Núñez-Mora, J.A. y Ruiz-Porras, A. (2006). "Volatilidad del precio de la mezcla mexicana de exportación". *Economía, Teoría y Práctica*, 25, 37-52.

De-Jesús-Gutiérrez, R. (2016). “Estrategias dinámicas de cobertura cruzada eficiente para el mercado del petróleo mexicano: Evidencia de dos modelos GARCH multivariados con término de corrección de error”. *Economía, Teoría y Práctica*, 44, 115-146.

De-Jesús-Gutiérrez, R. y Carvajal-Gutiérrez, L. (2013). “Modelación y predicción de la volatilidad con innovaciones de colas pesadas distribuidas: Evidencia empirica para los petróleos Maya y Mezcla Mexicana de Exportación”. *Paradigma Económico*, 5(1), 67-105.

De-Jesús-Gutiérrez, R., Vergara-González, R. y Diaz-Carreño, M.A. (2015). “Predicción de la volatilidad en el mercado de petróleo mexicano ante la presencia de efectos asimétricos”. *Lecturas de Economía*, 34(65), 299-326.

Engle, R.F. (1982). “Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation”. *Econometrica,* 50(4), 987-1007.

Engle, R.F. y Kroner, K.F. (1995). “Multivariate simultaneous generalized ARCH”. *Econometric Theory*, 11(1), 122-150.

Fan, L. y Li, H. (2015). "Volatility analysis and forecasting models of crude oil prices: A review". *International Journal of Global Energy Issues*, 38(1-3), 5-17.

Fattouh, B. (2007). “The drivers of oil prices: the usefulness and limitations of non-structural model, the demand-supply framework and informal approaches”. *EIB Papers*, 12(1), 128-156.

Ferderer, J.P. (1996). “Oil price volatility and the macroeconomy”. *Journal of Macroeconomics*, 18(1), 1-26.

Guo, H. y Kliesen, K.L. (2005). “Oil price voatility and US macroeconomic activity”, *Federal Reserve Bank of St. Louis Review*, 87(6), 669-683.

Hamilton, J.D. (1983). “Oil and the macroeconomy since World War II”. *Journal of Political Economy*, 91(2), 228-248.

Hilyard, J.F. (2012). *The Oil and Gas Industry: A Non-Technical Guide.* Tulsa, US: Pen Well.

IMP (2014). “Tipos de Petróleo”. *Instituto Mexicano del Petróleo*. Ciudad de México, México: Instituto Mexicano del Petróleo.

Iranzo, J.E. (1993). La OPEP: Del esplendor a la decadencia. En González, S., (coord.). *Temas de Organización Económica Internacional* (209-218). Madrid, España: McGraw-Hill.

López-Sarabia, P. y Venegas-Martínez, F. (2010). “Sobre la eficiencia de las coberturas petroleras contratadas con opciones de venta: Un análisis con modelos GARCH”. *Eseconomía*, 26, 7-23.

Lorenzo-Valdés, A., Durán-Vázquez, R. y Armenta-Fraire, L. (2012). "Conditional correlation between oil and stock market returns: The case of Mexico". *Revista Mexicana de Economía y Finanzas*, 7(1), 49-63.

Minovic, J.Z. (2009). "Modeling multivariate volatility processes: Theory and evidence". *Theoretical and Applied Economics*, 5(1), 21-44.

Morck, K.A. (1989). "Oil and the macroeconomy when prices go up and down: An extension of Hamilton's results". *Journal of Political Economy*, 97(3), 740-744.

OPEC. (2016). "OPEC Monthly Oil Market Report (18 January 2016)". *Organization of the Petroleum Exporting Countries*. Viena, Austria: Organization of the Petroleum Exporting Countries.

OPEC. (2014). "2014 World Oil Outlook". *Organization of the Petroleum Exporting Countries*. Viena, Austria: Organization of the Petroleum Exporting Countries.

Papapetrou, E. (2001). "Oil price shocks, stock market, economic activity and employment in Greece". *Energy Economics*, 23(5), 511-532.

Regnier, E. (2007). "Oil and energy price volatility". *Energy Economics*, 29(3), 405-427.

Sadorsky, P. (1999). "Oil price shocks and stock market activity". *Energy Economics*, 21(5), 449-469.

Sánchez Albavera, F. y Vargas, A. (2005). *La Volatilidad de los Precios del Petróleo y su Impacto en América Latina*. Santiago de Chile, Chile: Comisión Económica para América Latina y el Caribe.

SHCP (2015). "Ley de Ingresos de la Federación para el Ejercicio Fiscal de 2016". *Secretaria de Hacienda y Crédito Público*. Ciudad de México, México: Gobierno Federal.

Zakoian, J.M. (1994). "Threshold heteroskedastic models". *Journal of Economic Dynamics and Control*, 18(5), 931-055.

*Ensayos Revista de Economía- Volumen XXXV, núm.2, noviembre 2016, pp. 195-223*

# Disadvantaged? Informal Female Entrepreneurs Operating "Tienditas" in Nicaragua

## *¿Desaventajadas? Mujeres empresarias informales operando tienditas en Nicaragua*

Michael J. Pisani*

Fecha de recepción: 23 II 2016 Fecha de aceptación: 22 IX 2016

**Abstract**

I explore the business and (household) income outcomes of base of the pyramid (BoP) in-home convenience store entrepreneurs through a census-like business survey in Nicaragua. Throughout Latin America and in Nicaragua, *tienditas* are typically operated by female entrepreneurs in an informal regulatory environment out of the home and at the periphery of developing economies. Some authors have characterized this sector as disadvantaged because of its inherent reliance on female ownership, on a home-based location, and on operating within an informal context (Nichter and Goldmark, 2009). Others have argued that such enterprises may serve as a link toward poverty reduction at the BoP (Pisani and Yoskowitz, 2012). Utilizing a 2012 cross-sectional and nationally representative business focused survey, 400 Nicaraguan *tenderas* are examined. Findings indicate heterogeneity exists across the *tiendita* retail sector; where failing, ailing, stable and healthy *tienditas* are segmented, analyzed, and discussed.

***JEL Classification:*** L26, O17, D22, O54.
***Keywords:*** Informality. Female Entrepreneurship. *Tienditas*. Nicaragua.

**Resumen**

En este trabajo, se estudia el negocio y los ingresos (del hogar) en la base de la pirámide (BoP, por sus siglas en inglés) de tiendas de conveniencia ubicadas dentro del hogar en Nicaragua, a través de una encuesta empresarial tipo censo. En toda América Latina y en Nicaragua, las tienditas son

* Professor of International Business at Central Michigan University. Address: 204C Smith Hall, Mt. Pleasant, Michigan 48859 USA. Email: m.pisani@cmich.edu. Telephone: 989-774-3450. Fax: 989-774-1353

típicamente operadas por mujeres microempresarias en un entorno informal y en la periferia de las economías en desarrollo. Algunos autores han caracterizado a este sector como en desventaja debido a su dependencia inherente a la propiedad femenina, su ubicación dentro del hogar, y a su operación informal (Nichter y Goldmark, 2009). Otros han argumentado que tales empresas pueden servir para reducir la pobreza en la BoP (Pisani y Yoskowitz, 2012). Utilizando una encuesta del 2012 de corte transversal y representativa en el nivel nacional, se examinan 400 tenderas nicaragüenses. Los resultados indican que existe heterogeneidad en el sector minorista de las tienditas; las cuales se clasifican como saludables, estables, enfermas y fracasadas, para su análisis y discusión.

***Clasificación JEL:*** L26, O17, D22, O54.
***Palabras Clave:*** Informalidad. Microempresarias. Tienditas. Nicaragua.

## Introduction

Nichter and Goldmark (2009) recently conducted a thorough and comprehensive literature review linking MSE (micro and small enterprise) characteristics and other associated factors to firm growth. From this review, they developed a model that may help distinguish between MSEs mired in survival mode ("survivalists") versus those MSEs poised for rapid growth ("latent gazelles"). They found that the *most* disadvantaged survivalist firms happen to be those MSEs that are female-owned, informal, and home-based within developing country economic contexts. Acknowledging these structural barriers to MSE growth, I seek to disaggregate this market segment through the analysis of a single retail sub-sector: the *tiendita* in Nicaragua. The *tiendita* uniquely exhibits the structural disadvantages argued by Nichter and Goldmark (2009), but at the microenterprise scale.

In Latin America and Nicaragua, the *tiendita*, while seemingly everywhere, is often overlooked as a subject of study because the *tiendita* is so familiar and ordinary to most consumers. The ordinary nature of the *tiendita* does not dismiss its importance as an object of study; rather because the *tiendita* is so commonplace, increasing our understanding about this microenterprise, if only incrementally, may help sharpen our focus concerning primarily female micro-entrepreneurship. The *tiendita*, or barrio-based convenience store, more closely resembles a microenterprise than a small business because very few *tienditas* employ more than a single employee, though most utilize one to two unpaid family members (Pisani and Yoskowtiz, 2012).
Academic researchers have classified microenterprises as business entities with typically five or fewer employees, engaged in non-primary activities,

and selling at least 50% of their output (Mead and Liedholm, 1998)[1]. Mead and Liedholm (1998) found that working proprietors, or one-person shops, accounted for over half of all microenterprise employment in the developing world. Extending the workplace to unpaid family members within working proprietorships accounts for over 75% of all workers engaged in microenterprise establishments (Mead and Liedholm, 1998).

In this paper, I accept Nichter and Goldmark's (2009) call to segment a sub-sector they label as "survivalist" in a developing world context with firms facing many of the same key characteristics. If these most disadvantaged microenterprises exhibit heterogeneity (i.e., performance differences), then policy prescriptions may be further refined to distinguish between healthy, stable, ailing, and failing firms in the most distressed compartments of the business community. In turn, policy innovations which heal distressed *tienditas*, and which facilitate the creation, maintenance, and expansion of healthy *tienditas*, may play an important role in a comprehensive policy approach toward poverty mitigation at the base of the pyramid. It is precisely because of the ubiquitous nature of *tienditas* and the primary role female entrepreneurs play in their operation that it is essential to better understand this phenomenon in developing market contexts and determine if they are truly disadvantaged. More formally, I ask the following research question: *What distinguishes healthy, stable, ailing, and failing "survivalist" microenterprises?* (Given the same sub-sector [*tienditas*] and business pre-conditions of female-owned, in the home, and informal.)

The remainder of the paper is organized as follows: section one presents an overview of *tienditas*, including a review of the associated literature of female entrepreneurship, informality, and Nicaraguan national context. Section two reviews the data source and describes the research methodology. Section three presents the results concerning the heterogeneity and segmentation of *tienditas*. Section four provides a discussion and policy implications of these results. The last section concludes the paper.

## 1. *Tienditas* in Context

### *1.1 Overview of Tienditas*

*Tienditas* are pervasive throughout Latin America. The in-house convenience or tiny grocery store is typically found in the relatively poorer or underdeveloped sections of the country—such as shantytowns, rural hamlets,

[1] This is in contrast to SMEs which usually allow for firm size to include up to 50 employees.

and urban barrios. The *tiendita* caters to a nearby clientele that is bound to the neighborhood by location, primarily the result of mobility constraints resulting from a lack of financial resources, inadequate transportation alternatives, and poor job prospects. In Nicaragua, more than half of urbanites and roughly three-quarters of rural residents chose *tienditas* as their primary shopping outlet (D'Haese, Van de Berg, and Speelman, 2008).

The in-house convenience store typically devotes and converts the front section of the home to a selling space or retail outlet. The basic stock of a *tiendita* includes staple food supplies, hygienic products, junk food, school supplies, and other specialty items depending upon the *tiendita*. Start-up costs for *tienditas* in Nicaragua may be relatively small, oftentimes less than $100 (Pisani and Yoskowitz, 2012)[2]. The typical *tiendita* is open from six in the morning until eight in the evening, seven days per week. For the best and most regular customers, *tienditas* may extend credit. The workforce principally comes from the family unit, typically under the direction of the wife, who is almost always at home because of the home-based location of the business, and is generally supported by other family members in the household (Haase, 2007). While there are many similarities among *tienditas*, differences in economic structure and performance exist within the *tiendita* market segment. Some of the major differences uncovered include start-up costs, inventory size, financing, profits, and firm growth, illustrating heterogeneity among *tienditas* (Pisani and Yoskowitz, 2012).

Berner et al. (2012) more generally assert and add that small neighborhood stores in developing markets are "part of a strategy of increasing [household] security through diversification, and profits are only one part of the household income, whereas other sources such as formal or informal wage labor are more often irregular and insecure." They suggest that while "the shop brings in inadequate but steady earnings that help to bridge more difficult periods," the business may also be a "form of saving that can be consumed [or liquidated] in case of emergency."

### *1.2 Tienditas and Female Entrepreneurship in Developing Contexts*

*Tenderas* are female microentrepreneurs and owners of *tienditas,* and as such self-employed, where entrepreneurship refers to own-account employment (Blanchflower and Oswald, 1998). While not all *tienditas* are owned and operated by women in Nicaragua, nearly nine out of ten *tienditas* are female-owned and operated (Pisani, 2017). As women play a dominant consumptive role in the household as buyers of food and basic household goods in local

[2] All monetary amounts in this paper have been converted to US dollars.

stores and markets, these skills are transferable in many ways to the operation of a *tiendita*.

*Tiendita* ownership offers *tenderas* the ability in a traditional cultural environment to be home-based where oftentimes familial duties for women (e.g., caring for children, maintaining the household) are prioritized ahead of activities outside the home (Pisani and Yoskowitz, 2012). Yet, women in Nicaragua have also engaged in important and public ways outside the home, especially during the revolutionary years of the 1980s (Kampwirth, 2012). Hence female entrepreneurship in Nicaragua is readily on display (Pisani, 2006), but it is more accepted if it is in the confines of the home or safe spaces.

More broadly, Adom (2015) in his qualitative study of 60 informal female entrepreneurs in Accra, Ghana, argues that "there remains untapped potential for female entrepreneurs becoming key players for achieving economic development" in emerging markets. This is especially true for "the few opportunity-driven [entrepreneurs who] have the potential for sustainable economic development" (Adom, 2015).

Entrepreneurs at the Base of the Pyramid (BoP) have been described as lying on a continuum between necessity-driven entrepreneurs (own-account business owners without other employment options) and opportunity-driven entrepreneurs (own-account business owners by choice, exploiting a market niche [Kirzner, 1973]). Margolis (2014) argues "countries with weaker social protection systems" are "more likely to have a higher share of necessity-driven, as opposed to choice-driven, self-employed." This continuum may also be gendered as argued by Williams and Youssef (2013) who find that informal female entrepreneurs in Brazil are more likely operating necessity driven enterprises while earning less than their male peers. For example, Williams (2008, 2007) observed that both necessity and opportunity drive many into informal entrepreneurship. Gurtoo and Williams (2009) find that in India self-employed informals may be necessity and/or opportunity driven over time, illustrating microenterprise life cycle dynamism as the motivation to participate in the informal economy.

Calderon et al. (2016) in their large sample of urban-based female entrepreneurs in Mexico note that opportunity-driven entrepreneurs earn higher profits, engage in better management practices, attain higher education levels, and possess personality traits associated with positive business outcomes than necessity-driven entrepreneurs. The authors also find that opportunity-driven entrepreneurs only constitute 21% of female entrepreneurs in their study. Stam and van Stel (2011) suggest higher levels of entrepreneurship and necessity-driven entrepreneurship exists in low-

income countries due to a lack of alternative earning activities. Stam and van Stel also attempt to connect necessity entrepreneurship with economic growth in middle-income countries, but their results are mixed and inconclusive. They do suggest that if it were possible to distinguish between entrepreneurial enterprises, the result might help direct or redirect scarce public resources to encourage entrepreneurship that also fosters national economic growth. Berner et al. (2012) suggest further that survivalist microbusiness concerns, such as small neighborhood informal stores are mostly "run by mothers of young children, elderly persons or anyone else who has no chance to earn money in another way – people with so-called zero opportunity costs." Yet the authors suggest these microbusinesses may be "a different target group, requiring different [policy] interventions based on a different logic" (Berner et al., 2012). Stam and van Stel (2011) caution governments, however, that they "should avoid" making resources "available through government stimulation programs" that "are absorbed by necessity entrepreneurs with low human capital" because of the low probability that such programs will induce wider economic growth.

### *1.3 Tienditas and Informality*

*Tienditas* are mostly informal business concerns as are the majority of the microenterprises in developing countries and Central America (Funkhouser, 1996; Jain and Pisani, 2008; Pisani and Pagán, 2004; Pisani and Ysokowitz, 2012). The retail function of *tienditas* may be performed under the auspices of government regulators and tax collectors, but more often than not, the government is absent from *tiendita* oversight. This hidden from government purview employment has been referred to as informal employment (Hart, 1973, 1970). In essence work "activities that avoid state regulation" and supervision best describes informality (Itzigsohn, 2000). The informal condition is especially true for micro-entrepreneurs unaware of registration requirements and for those microbusiness establishments located away from government office and authorities (Pisani and Yoskowitz, 2012).

Kahn and Khan (2009) suggest that in Pakistan, women work informally to help poor families improve their survival chances. They also report that "there are strong rigid cultural constraints, which restrict mobility and handicap them [women] for having employment outside the home for remuneration. However, their struggle for family survival is accepted," this is particularly the case under circumstances of extreme poverty. Occasionally, researchers have noted a progression for some informal firms to move up, either in stature, as Achua and Lussier (2014) uncovered in Cameroon where some itinerant street vendors become brick and mortar store owners, or as Pisani et al. (2008) discovered along the Texas-Mexico border of informal businesses formalizing their operations. The approach to studying informality

is no longer the realm of dualistic labor market (Peattie, 1987), but a dynamic continuum of market-based outcomes (Richardson and Pisani, 2012).

### *1.4 Nicaraguan National Context*

Contemporary Nicaragua has faced many challenges including natural disasters (e.g., earthquakes and hurricanes), social, economic, and political upheaval (e.g., revolution, counter-revolution, and revolution restored), external pressures and shifting alliances (e.g., the oscillating roles of the US, socialism, the Nicaraguan diaspora, and Venezuela), and widespread poverty (e.g., about three-fourths of the current population lives on $2 or less per day [World Food Programme, 2014]) (Walker and Wade, 2011). More recently, the political landscape has been dominated by Sandinista Daniel Ortega who has held the presidency since 2007. Under Ortega's leadership, the nation's foreign policy has titled to the left and aligned the state with the Bolivarian alliance centered in Venezuela. Economically, the nation is tied to the capitalist global market, in particular the United States and the CAFTA region plus Venezuela.

Nicaragua, with approximately six million inhabitants, is the second poorest country in the Western Hemisphere with a 2014 per capita GDP of $1,870 with about one-third of households living below the national poverty line (World Bank, 2016). Presently the economy is growing between four and six percent per year with moderate inflation under ten percent (Banco Central de Nicaragua, 2015). Informal employment remains persistently high at about 75% of all employed Nicaraguans. There is a direct relationship between informality and self-employment which are both inversely related to per capita income (Xavier et al., 2012). Hence, self-employment remains an important economic employment outlet and driver of the economy with self-employment comprising roughly one-third of the economically active population (Banco Central de Nicaragua, 2013, Pisani and Pagán, 2004). The composition of the $10 billion economy is about 35% services, 35% manufacturing, and 30% agriculture. The economy is very open to global trade with imports and exports comprising 105% of GDP and overseas remittances accounting for 10% of GDP (Banco Central de Nicaragua, 2013). Lastly, the capital city, Managua, is a classic Latin American primate city containing about half of the nation's population and is the hub of the nation's economic activity.

## 2. Research Methodology

In order to explore the degree of heterogeneity among female owned *tienditas*, a recent business survey conducted in Nicaragua was utilized. The cross-sectional data set, *bases de datos de la encuesta continua de hogares*

*[ECH] (II trimester del 2012)*[3], employed in this paper was accessed through the Nicaraguan *Insituto Nacional de Información de Desarrollo* (INIDE). Partial external support for the survey came from the Economic Commission for Latin America and the Caribbean and the International Labour Office. The ECH survey was deployed by INIDE and completed in Nicaragua from April to June 2012 with a primary focus on economic activity. The household questionnaire contains categorical and ratio data concerning the household roster and demographics and employment. The random national household survey included 6,811 households spread representatively across the country and included 31,281 persons[4].

*Tienditas* were identified utilizing two ECH survey questions in combination: occupation as shop keeper (*vendedores y demostradores de tiendas y almacenes*) and location of business (*en su propia vivienda*). Hence only stores located in one's home were included. As the weighting mechanism was not adequately described in the ECH survey documentation or provided in the accompanying data set, no weighting was used in the empirical analysis reported in the results section of the paper. However, preliminary extrapolation may suggest a national total of 213,500 Nicaraguans employed in 91,313 *tienditas* across the country[5]. Of these projections, perhaps as many as 77,707 *tienditas* are female owned and operated employing 140,483 women. The final results utilized in this article display survey information collected for 400 *tenderas*.

The 2012 Nicaraguan national poverty line is used as a benchmark to segment healthy, stable, ailing, and failing firms. This is in line with other researchers who have used similar benchmarks to delineate success among microenterprises. For example, Gindling and Newhouse (2012) classify success with "per capita consumption above the $2/day poverty line." Those *tienditas* earning returns clearly above the poverty line are considered healthy, around the poverty line are considered stable, just below the poverty line are considered ailing, and far below the poverty line are failing firms due to their extreme impoverishment.

[3] The data set and accompanying material are available at: http://www.inide.gob.ni/.

[4] The representative national sample of households, or sampling frame, was selected randomly from approximately the same number of households from each department of Nicaragua except the capital city of Managua, where that number was tripled. Care was taken to include both urban and rural households in the same proportion as the population in the region. The universe of households (7,460) was derived from previous censuses, voter registration rolls, and validated with field observation. The non-response rate was 8.7%. De Mel, McKenzie, and Woodruff (2009) note that surveys involving microenterprises reveal comparable data as that derived from detailed firm diaries suggesting that business surveys are robust. Overall, the quality of the data and sample utilized here are considered good.

[5] No specialized government census of *tienditas* exists for Nicaragua.

The Fundación Internacional para el Desafío Económico Global[6], or FIDEG, a Nicaraguan non-governmental organization funded in part by the Swiss Agency for Development and Cooperation in Central America, the Finish Embassy, and the Canadian International Development Agency, conducted 1,730 household surveys throughout the country in 2012 to measure poverty in the country (FIDEG, 2013). The 2012 surveys were random and national in scope and scale and measured the poverty line at $2 per person per day. The same report noted that extreme poverty was present measured by earnings of $1 per person per day or less.

Support for segmenting enterprises within the informal sector comes from Grimm, Knorringa, and Lay (2012), who find three such groups (top-performers, constrained gazelles, and survivalists) in their expansive study of French West Africa. Berner, Erhard, and Knorringa (2012) present a typology of survivalist and growth-oriented enterprises in the informal sector. As such, I utilize the following daily earnings benchmarks for segmenting healthy, stable, ailing, and failing firms (*tienditas*) in this study: $4 or more, healthy; $2 to $4, stable; $1 to $2, ailing; and below $1, failing.

A set of *a priori* variables are utilized in line with previous research conducted with *tienditas* in the region (Pisani and Yoskowitz, 2012, 2010; Pisani, 2017, 2013, 2010). Demographic variables include region of residence, urban or rural nature of residence, the number of people living in the household, age, education and literacy, civil (marital) status, and income. Variables utilized for enterprise characteristics include length of work year, income, hours worked, record keeping, number of employees, desire, rationale, and action to change jobs, and second employment and second employment hours worked. Additional variables used in the statistical analyses (i.e., multiple regression, cross-tabulations) include years of potential work experience, remittances, and transfer income.

## 3. Results

In this section, results are presented to provide insight into the four identified groups of *tiendita* enterprises: healthy, stable, ailing, and failing firms. To begin this section, I contextualize *tenderas* and then segment *tienditas* by earnings per day. Then, I cluster *tienditas* earning profits of $1 or less a day, $1 to $2 a day, $2 to $4 a day, and more than $4 a day together; these groups represent 30.4%, 18.6%, 25.4%, and 25.6%, respectively, of all *tienditas* in

[6] In English the name translates as the International Foundation for Global Economic Challenge.

the sample. As $2 a day is a watershed measure for poverty in the country, these earning segments may be considered failing (dying), ailing (marginally subsistence), stable (survival), and healthy (opportunity oriented). Subsequently, multivariate analyses as to the determinants of business profits are presented. Lastly, household income in relation to potential poverty outcomes is offered.

*3.1 Tenderas (Female Tiendita Entrepreneurs)*

A demographic profile of female *tiendita* entrepreneurs and workers appears in Table 1. The survey is national in scope with all of the regions represented noting the principal importance of Managua. Urban areas house about two-thirds of *tiendita* owners and workers in households holding around five people, each reflective of the periphery location of *tienditas* and in-country population dynamics. *Tenderas* are on average middle-aged, a reflection of the accumulated capital necessary to launch, own, and operate a *tiendita* (Pisani and Yoskowitz, 2012). Most of the owners proclaim literacy, yet relative education levels are low (even when compared to *tiendita* employees) perhaps a result of impoverished life circumstances and constrained occupational choice for *tenderas*. The *tiendita* owner typically resides in married households generating earnings from the *tiendita*.

*3.2 Failing, Ailing, Stable, and Healthy Tienditas*

Firm characteristics for each *tendera* segment are offered in Table 2. Most *tenderas* work year around with the highest earning *tienditas* more likely to be open longer hours, employ more workers, and be open the whole year as compared to the lowest earning *tienditas*. Further, *tenderas* who earn more money keep more business records. Yet, just 35.3% of the most profitable *tendera* segment maintains separate bookkeeping accounts for their *tiendita*. No *tendera* was enrolled in social security reinforcing the informal nature of the sector. *Tenderas* most interested in changing jobs seek higher incomes and are, unsurprisingly, those in the lowest income segments. About one-fifth of *tenderas* were actively in the search for alternate work at the time of the survey with the highest *tendera* earners the most active in the alternate work search. All segments reported relatively large minorities of *tenderas* working a second job averaging more 11.0 hours a week with the highest *tenderas* earners also working the longest hours at a second job.

Table 1
***Tiendita* Demographics: Female Entrepreneurs**

| **Variable** | **Entrepreneurs/*Tenderas*** |
|---|---|
| Region* (%) | |
| Segovias | 11.0 |
| Western | 18.2 |
| Managua | 28.8 |
| Southern | 10.0 |
| Central | 7.0 |
| Northern | 11.0 |
| Atlantic | 14.0 |
| Residence Urban/Rural | |
| Urban | 66.0 |
| Rural | 34.0 |
| Mean Household Size (std. dev.) | 4.9 (2.6) |
| Mean Age (std. dev.) | 46.2 (15.2) |
| Literate (%) | |
| Yes | 84.0 |
| No | 16.0 |
| Education – Last School Attended (%) | |
| None | 18.0 |
| Primary | 45.0 |
| Secondary | 25.7 |
| Technical | 3.3 |
| University | 8.0 |
| Mean Education – Years (std. dev.) | 5.9 (4.4) |
| Civil Status (%) | |
| Single | 3.5 |
| Married (includes unions) | 63.0 |
| Separated/Divorced | 24.0 |
| Widowed | 9.5 |
| Earned Income/Paid in the *Tiendita* (%) | |
| Yes | 99.0 |
| No | 1.0 |
| N= | 400 |

Source: Author's calculations derived from: *bases de datos de la encuesta continua de hogares [ECH] (II trimester del 2012)*, Nicaraguan *Insituto Nacional de Información de Desarrollo.* *Region is grouped as Segovias: Estelí, Madriz, Nueva Segovia; Western: León, Chinandega; Managua; Southern: Granada, Masaya, Carazo, Rivas; Central: Boaco, Chontales; Northern: Jinotega, Matagalpa; and Atlantic: Río San Juan, RAAN, RAAS.

Table 2
**Female Owned *Tiendita* Firm Characteristics (as primary occupation)**

| Variable | $1/day < Failing | $1-$2/ day Ailing | $2-$4/ day Stable | > $4/day Healthy | All |
|---|---|---|---|---|---|
| Work as a *Tendera* Year Round?* (%) | | | | | |
| Yes | 79.3 | 82.4 | 85.1 | 89.2 | 83.8 |
| No (seasonal/other) | 21.7 | 17.6 | 14.9 | 10.8 | 16.3 |
| Earned *Tiendita* Income Over the Past Month? (%) | | | | | |
| Yes | 96.7 | 100 | 100 | 100 | 99.5 |
| No | 3.3 | 0 | 0 | 0 | 0.5 |
| *Amount Earned in Tiendita – Monthly Profits ($US)* | | | | | |
| *Mean* | *16.45* | *43.18* | *84.49* | *200.8* | 85.17 |
| *Standard Deviation* | *7.7* | *6.63* | *12.45* | *89.06* | 85.38 |
| *Hours Worked per Week* | | | | | |
| *Mean* | *25.8* | *37.3* | *48.3* | *53.2* | 40.57 |
| *Standard Deviation* | *19.5* | *20.3* | *23.6* | *18.5* | 23.27 |
| Keep Bookkeeping Records? (%) | | | | | |
| Yes | 21.5 | 29.7 | 29.7 | 35.3 | 29 |
| No | 78.5 | 70.3 | 70.3 | 64.7 | 71 |
| *Number of Employees (%)* | | | | | |
| *0* | *39.7* | *35.1* | *21.8* | *14.7* | 27.8 |
| *1-4* | *60.3* | *64.9* | *77.2* | *84.3* | 71.8 |
| *5-8* | *0* | *0* | *1* | *1* | 0.5 |
| Enrolled in Social Security? (%) | | | | | |
| Yes | 0 | 0 | 0 | 0 | 0 |
| No | 100 | 100 | 100 | 100 | 100 |
| Do you wish to change jobs? (%) | | | | | |
| Yes | 35.5 | 35.1 | 30.7 | 24.5 | 31.5 |
| No | 64.5 | 64.9 | 69.3 | 75.5 | 68.5 |

| | | | | | |
|---|---|---|---|---|---|
| Rationale for those indicating they wish to change jobs: (%) | | | | | |
| Increase income | 93 | 96.2 | 96.8 | 96 | 94.4 |
| Better use my skills | 0 | 3.8 | 0 | 0 | 0.8 |
| Other | 7 | 0 | 3.2 | 4 | 4.8 |
| Have you looked for other work over the past 3 months? (%) | | | | | |
| Yes | 18.6 | 11.5 | 25.8 | 32 | 21.6 |
| No | 81.4 | 88.5 | 74.2 | 68 | 78.4 |
| Do you have a second job? (%) | | | | | |
| Yes | 28.9 | 33.8 | 31.7 | 28.4 | 30.2 |
| No | 71.1 | 66.2 | 68.3 | 71.6 | 69.8 |
| *Hours Worked per Week in Second Job* | | | | | |
| *Mean* | *8.3* | *11.1* | *10.7* | *14.6* | 11 |
| *Standard Deviation* | *5.4* | *8.8* | *6.4* | *8.3* | 7.43 |
| N= | 121 | 74 | 101 | 102 | 398 |

Source: Author's calculations derived from: *bases de datos de la encuesta continua de hogares [ECH] (II trimester del 2012),* Nicaraguan *Insituto Nacional de Información de Desarrollo.* *Italics = significant difference at the .10 level.

### *3.3 Multivariate Analysis for Principal Tendera Ownership Profits*

To better understand the determinants of business profits, I estimated multiple regression analyses utilizing 14 preselected (a priori) variables. These variables include region (Managua [=1] or rest of the country), residence (urban [=1] or rural), household size (number of persons living in the household), potential experience[7] (this estimates the amount of potential work experience, calculated as age minus years of education minus 6), potential experience squared divided by 100 (to uncover any nonlinear returns to experience), literacy (literacy = 1), years of education, civil status (married [=1] or not married), foreign remittances (=1 if household receives foreign remittances), keep business records (=1 if *tiendita* keeps separate business records), have employees (=1 if *tiendita* has employees), wish to change jobs (=1 if *tendera* indicated a desire to change jobs), have a second

[7] Because of multicollinearity issues, age was removed from the multiple regression analysis. Age is however embedded in the potential experience variables.

job (=1 if *tendera* possess a second job), and number of hours worked per week. The dependent variable is business profits per hour (constructed from monthly business profits and hours worked per week variables). The significant multiple regression results for each *tiendita* segment is reported below as is a composite and summary. I begin with the composite and end with a summary.

For all *tienditas* together, five independent variables significantly impact and are associated with *tendera* profits: region, potential experience squared/100, business record keeping, wish to change jobs, and hours worked (see Table 3A). *Tenderas* located in Managua earned a $0.26 per hour premium over those *tenderas* located throughout the rest of the country. The returns to potential work experience were nonlinear and negative for women indicating diminishing profits the longer one stayed in business (at a rate of $0.02 per hour). Business record keeping boosted hourly profits $0.16 for *tenderas*. *Tenderas* wishing to change jobs saw diminished hourly profits of $0.23. Finally, the longer *tenderas* worked in the *tiendita* the less she profited per hour by $0.02 per hour[8].

Regional location and the number of hours worked by the *tendera* are the significant variables associated in determining profits for failing *tienditas* (see Table 3B). *Tenderas* operating in Managua improved their earnings by $0.22 per hour over *tienditas* operating outside the capital. Additionally, the longer the *tendera* worked in the *tiendita* the lower were her returns at the rate of $.01 per hour. Five variables are significant for determining profits in ailing firms: regional location, potential experience and its square/100, record keeping, and hours worked (see Table 3C). Enhancing hourly earnings are regional location in Managua ($0.72), potential work experience ($.05) and the maintenance of business records ($0.48). Two variables diminish earnings; these are the non-linear returns to experience ($0.06) and the number of hours worked by the *tendera* in the *tiendita* ($0.04). Hourly computed profits for stable *tienditas* benefit from remittance flows ($0.63) and are stunted by additional time spent in the *tiendita* by the *tendera* ($0.03) (see Table 3D). Lastly, hourly profits for healthy *tienditas* are augmented by regional location in Managua ($0.29) and reduced by the *tendera* working longer hours in her *tiendita* ($0.03) (see Table 3E).

[8] Additionally, the multiple regression model for monthly profits for second business ownership proved insignificant. Nevertheless, one variable impacted second business profits: receipt of foreign remittances. Indeed, foreign remittances augmented hourly profits by $1.48. Hence, assistance from abroad may help create and sustain a notable secondary income. Nevertheless, this result is only to be understood as illustrative of the potential remittances may have on second business income.

In summary, two variables were significant in more than one segment: region and number of hours worked. Regional location within the economic hub of the nation —Managua— improved earnings for all *tienditas* generally and for three of the four segments individually. Based upon the average number of hours worked by *tenderas* in each significant *tiendita* segment, regional location in Managua improved earnings on average for failing firms by $22.68 per month, for ailing firms by $107.44 per month, and for healthy firms by $40.96 per month. Also the more time *tenderas* spent working within their own *tiendita* reduced average monthly income across all segments by $1.03, $5.96, $5.80, and $6.38, respectively, among failing, ailing, stable, and healthy *tienditas*.

Table 3A
**Multiple Regression *Tiendita* Hourly Profits –Female Owners (*Tenderas*)**

| Variable | All *Tienditas* β | Standard Error | t statistic | Significance |
|---|---|---|---|---|
| Constant | 1.005 | .253 | 3.970 | .000*** |
| Region (Managua=1) | .262 | .097 | 2.694 | .007*** |
| Residence (Urban=1) | .107 | .095 | 1.122 | .263 |
| Household Size | -.009 | .016 | -.600 | .549 |
| Years of Potential Experience (PE) | .011 | .009 | 1.197 | .232 |
| PE Squared/100 | -.020 | .012 | -1.723 | .086* |
| Literacy (Yes=1) | .071 | .134 | .531 | .596 |
| Years of Education | .004 | .013 | .289 | .773 |
| Civil Status (Married=1) | -.011 | .088 | -.125 | .900 |
| Foreign Remittances (Yes=1) | .139 | .176 | .790 | .430 |
| Keep Business Records (Yes=1) | .160 | .092 | 1.740 | .083* |
| Have Employees (Yes=1) | .142 | .094 | 1.508 | .132 |
| Wish to Change Jobs (Yes=1) | -.227 | .089 | -2.566 | .011** |
| Have Second Job (Yes=1) | -.049 | .088 | -.556 | .579 |
| Hours Worked in *Tiendita* (Week) | -.016 | .002 | -8.359 | .000*** |
| Adjusted $R^2$ = .144 | | | | |
| Model ANOVA: F= 5.726, df=14, p=.000*** | | | | |

Source: Author's calculations derived from: *bases de datos de la encuesta continua de hogares [ECH] (II trimester del 2012),* Nicaraguan *Insituto Nacional de Información de Desarrollo.* ***, **, * represent statistical significance at the 0.01, 0.05, and 0.10 levels, respectively.

Table 3B

**Multiple Regression *Tiendita* Hourly Profits –Female Owners (*Tenderas*)**

| Variable | Failing *Tienditas* β | Standard Error | t statistic | Significance |
|---|---|---|---|---|
| Constant | .872 | .213 | 4.090 | .000*** |
| Region (Managua=1) | .217 | .091 | 2.388 | .019** |
| Residence (Urban=1) | -.051 | .090 | -.561 | .576 |
| Household Size | -.019 | .013 | -1.480 | .142 |
| Years of Potential Experience (PE) | .002 | .007 | .256 | .798 |
| PE Squared/100 | -.005 | .009 | -.541 | .590 |
| Literacy (Yes=1) | -.155 | .116 | -1.335 | .185 |
| Years of Education | .003 | .013 | .240 | .811 |
| Civil Status (Married=1) | .063 | .077 | .815 | .417 |
| Foreign Remittances (Yes=1) | .089 | .142 | .623 | .535 |
| Keep Business Records (Yes=1) | -.039 | .090 | -.438 | .662 |
| Have Employees (Yes=1) | -.061 | .080 | -.766 | .446 |
| Wish to Change Jobs (Yes=1) | -.089 | .082 | -1.087 | .280 |
| Have Second Job (Yes=1) | -.081 | .079 | -1.023 | .309 |
| Hours Worked in *Tiendita* (Week) | -.012 | .002 | -5.781 | .000*** |
| Adjusted $R^2$ = .276 | | | | |
| Model ANOVA: F= 4.213, df=14, p=.000*** | | | | |

Source: Author's calculations derived from: *bases de datos de la encuesta continua de hogares [ECH] (II trimester del 2012)*, Nicaraguan *Insituto Nacional de Información de Desarrollo*. ***, **, * represent statistical significance at the .01, .05, and .10 levels, respectively.

Table 3C
**Multiple Regression *Tiendita* Hourly Profits –Female Owners (*Tenderas*)**

| Variable | Ailing *Tienditas* β | Standard Error | t statistic | Significance |
|---|---|---|---|---|
| Constant | 1.088 | .644 | 1.689 | .097* |
| Region (Managua=1) | .716 | .230 | 3.117 | .003*** |
| Residence (Urban=1) | .088 | .215 | .410 | .683 |
| Household Size | -.032 | .047 | -.678 | .500 |
| Years of Potential Experience (PE) | .047 | .025 | 1.843 | .070* |
| PE Squared/100 | -.061 | .032 | -1.918 | .060* |
| Literacy (Yes=1) | -.049 | .287 | -.170 | .866 |
| Years of Education | -.002 | .029 | -.059 | .953 |
| Civil Status (Married=1) | .200 | .230 | .868 | .389 |
| Foreign Remittances (Yes=1) | -.590 | .554 | -1.065 | .291 |
| Keep Business Records (Yes=1) | .484 | .198 | 2.450 | .017** |
| Have Employees (Yes=1) | -.146 | .197 | -.741 | .462 |
| Wish to Change Jobs (Yes=1) | .094 | .182 | .517 | .607 |
| Have Second Job (Yes=1) | -.349 | .221 | -1.576 | .121 |
| Hours Worked in *Tiendita* (Week) | -.035 | .005 | -7.143 | .000*** |
| Adjusted $R^2$ = .420 | | | | |
| Model ANOVA: F= 4.725, df=14, p=.000*** | | | | |

Source: Author's calculations derived from: *bases de datos de la encuesta continua de hogares [ECH] (II trimester del 2012),* Nicaraguan *Insituto Nacional de Información de Desarrollo.* ***, **, * represent statistical significance at the .01, .05, and .10 levels, respectively.

Table 3D

**Multiple Regression *Tiendita* Hourly Profits –Female Owners (*Tenderas*)**

| Variable | Stable *Tienditas* β | Standard Error | t statistic | Significance |
|---|---|---|---|---|
| Constant | 2.022 | .406 | 4.978 | .000*** |
| Region (Managua=1) | .175 | .164 | 1.069 | .288 |
| Residence (Urban=1) | .259 | .167 | 1.556 | .123 |
| Household Size | -.013 | .026 | -.512 | .610 |
| Years of Potential Experience (PE) | .012 | .017 | .719 | .474 |
| PE Squared/100 | -.025 | .023 | -1.086 | .280 |
| Literacy (Yes=1) | .046 | .267 | .172 | .864 |
| Years of Education | -.010 | .024 | -.435 | .665 |
| Civil Status (Married=1) | -.119 | .150 | -.793 | .430 |
| Foreign Remittances (Yes=1) | .628 | .274 | 2.293 | .024** |
| Keep Business Records (Yes=1) | .202 | .150 | 1.348 | .181 |
| Have Employees (Yes=1) | .030 | .167 | .181 | .857 |
| Wish to Change Jobs (Yes=1) | -.142 | .148 | -.955 | .342 |
| Have Second Job (Yes=1) | -.163 | .156 | -1.042 | .300 |
| Hours Worked in *Tiendita* (Week) | -.030 | .003 | -9.696 | .000*** |
| Adjusted $R^2$ = .514 | | | | |
| Model ANOVA: F= 8.541, df=14, p=.000*** | | | | |

Source: Author's calculations derived from: *bases de datos de la encuesta continua de hogares [ECH] (II trimester del 2012)*, Nicaraguan *Insituto Nacional de Información de Desarrollo*. ***, **, * represent statistical significance at the .01, .05, and .10 levels, respectively.

Table 3E
**Multiple Regression *Tiendita* Hourly Profits –Female Owners (*Tenderas*)**

| Variable | Healthy *Tienditas* β | Standard Error | t statistic | Significance |
|---|---|---|---|---|
| Constant | 3.168 | .570 | 5.555 | .000*** |
| Region (Managua=1) | .289 | .172 | 1.680 | .097* |
| Residence (Urban=1) | .027 | .168 | .163 | .871 |
| Household Size | -.021 | .031 | -.686 | .495 |
| Years of Potential Experience (PE) | -.015 | .018 | -.862 | .391 |
| PE Squared/100 | .015 | .025 | .580 | .564 |
| Literacy (Yes=1) | .327 | .260 | 1.258 | .212 |
| Years of Education | -.020 | .022 | -.920 | .360 |
| Civil Status (Married=1) | .033 | .158 | .209 | .835 |
| Foreign Remittances (Yes=1) | -.188 | .340 | -.552 | .582 |
| Keep Business Records (Yes=1) | .021 | .160 | .130 | .897 |
| Have Employees (Yes=1) | -.097 | .205 | -.474 | .637 |
| Wish to Change Jobs (Yes=1) | -.235 | .169 | -1.391 | .168 |
| Have Second Job (Yes=1) | .019 | .159 | .119 | .906 |
| Hours Worked in *Tiendita* (Week) | -.033 | .004 | -7.947 | .000*** |
| Adjusted $R^2$ = .386 | | | | |
| Model ANOVA: F= 5.482, df=14, p=.000*** | | | | |

Source: Author's calculations derived from: *bases de datos de la encuesta continua de hogares [ECH] (II trimester del 2012)*, Nicaraguan *Insituto Nacional de Información de Desarrollo.* ***, **, * represent statistical significance at the .01, .05, and .10 levels, respectively.

### *3.4 Total Household Income in Tendera Homes*

Incomes of *tendera* households in this ECH sample reveal three main sources of income: principal occupation, secondary occupation, and monetary transfers. Total household income for *tendera* households is displayed in Table 4. Secondary occupational income averages about $10 per month for all *tenderas* as well as for *tenderas* working in ailing and stable *tienditas*. *Tenderas* in failing *tienditas* earn on average an additional $5.14 per month in their secondary employment whereas *tenderas* operating healthy *tienditas*

earn an extra $17.01 per month in their secondary occupation. Nearly all secondary employment is self-employment (85.1%) or additional work for another family business (11.6%). The most common secondary jobs included raising and selling chickens and other animals (24.8%), cooking and baking (24.8%), selling ice cream and ices (14.0%), sewing and washing clothes (11.6%), and work in another *tiendita* (8.3%). However, less than one-third of all *tenderas* engage in secondary employment with no discernible pattern across the four groups. Perhaps the time constraints associated with caring for the family, managing the household, and operating the *tiendita* are roadblocks for many to secondary employment.

Table 4
***Tendera* Household Income Across *Tiendita* Segments ($US)**

| | **Income Source** | | | | |
|---|---|---|---|---|---|
| **Principal Occupation** | **Failing** | **Ailing** | **Stable** | **Healthy** | **All** |
| Monthly Mean Amount (std. dev.) | 16.45 (7.70) | 43.18 (6.63) | 84.49 (12.45) | 200.80 (89.06) | 85.17 (85.38) |
| F=328.298, p=.000 | | | | | |
| Hourly Mean Amount (std. dev.) | 0.32 (0.43) | 0.58 (0.93) | 0.72 (0.89) | 1.11 (0.86) | 0.67 (0.83) |
| F=19.256, p= .000 | | | | | |
| **Secondary Occupation** | **Failing** | **Ailing** | **Stable** | **Healthy** | **All** |
| Monthly Mean Amount (std. dev.) | 5.14 (22.91) | 10.23 (25.46) | 9.90 (30.49) | 17.01 (62.07) | 10.33 (38.88) |
| F=1.736, p=.159 | | | | | |
| Hourly Mean Amount (std. dev.) | 0.21 (1.10) | 0.22 (0.54) | 0.25 (0.72) | 0.34 (1.23) | 0.25 (0.97) |
| F=.382, p=.766 | | | | | |
| **Transfer Income^** | **Failing** | **Ailing** | **Stable** | **Healthy** | **All** |
| Monthly Mean Amount (std. dev.) | 59.44 (49.00) | 80.40 (54.43) | 78.84 (48.42) | 176.03 (149.16) | 96.21 (97.18) |
| F=6.665, p=.001 | | | | | |
| **Total Income** | **Failing** | **Ailing** | **Stable** | **Healthy** | **All** |
| Monthly Mean Amount (std. dev.) | 34.36 (41.41) | 64.27 (40.60) | 102.32 (45.64) | 247.15 (137.37) | 111.70 (137.37) |
| F=149.093, p=.000 | | | | | |
| **Per Capita Household Income** | **Failing** | **Ailing** | **Stable** | **Healthy** | **All** |
| Monthly Mean Amount (std. dev.) | 10.50 (18.23) | 21.52 (28.33) | 29.43 (28.20) | 67.73 (47.39) | 32.02 (47.39) |
| F=36.746, p=.000 | | | | | |

Source: Author's calculations derived from: *bases de datos de la encuesta continua de hogares [ECH] (II trimester del 2012)*, Nicaraguan *Insituto Nacional de Información de*

*Desarrollo* *Italics = significant difference (ANOVA, comparison of means) across segments at the .001 level. ^Note: Only 67 households received transfer income, 26 for failing *tienditas*, 10 for *ailing tienditas*, 14 for stable *tienditas*, 17 for healthy *tienditas*. Transfer income is comprised of domestic and foreign remittances, social security, pensions, alimony, and local and foreign assistance.

Monthly transfer income, for those households that receive it, is substantial ($96.21 on average). Few households receive transfer income; the rate of receipt of such transfer income is 21.5%, 13.5%, 13.9%, and 16.7%, respectively for failing, ailing, stable and healthy *tienditas*. In fact, transfer income to the *tendera* household is more than the monthly business profits for *tenderas* operating failing and ailing *tenderas* and nearly as much as income derived in stable and healthy *tienditas*. In all, total average monthly household income rises above $100 for *tendera* households operating stable and healthy *tienditas*. On a per capita household basis, while incomes average $32.02 for *tendera* households collectively, there is a stark contrast across the segments with per capita household incomes of $10.50, $21.52, $29.43, and $67.73, respectively, across failing, ailing, stable and healthy *tiendita* households.

## 4. Discussion and Policy Implications

This study set out to distinguish among healthy, stable, ailing, and failing "survivalist" female owned microenterprises within the home-based informal *tiendita* market segment. Because of the size and importance of *tienditas* within Nicaragua as a source of BoP employment and goods distribution, it makes sense from a public policy perspective not only to engage the sector, but also to enhance economic and social outcomes where possible. While it is improbable that even the healthiest *tienditas* may be latent or constrained gazelles, 14 or 3.5% of the *tienditas* in the sample earned more than $300 a month with the monthly profits for the highest performing *tiendita* equaling $522. This finding is in concert with the typology of survivalist firms offered by Berner et al. (2012, p. 388) who suggest that fewer than 10% of informal microenterprises may be growth oriented as "most survival enterprises would start up and remain within the informal economy, a feature that goes together with the low barriers of entry typical of these enterprises." The low percentage of healthy *tienditas* are also consistent with Gindling and Newhouse (2012) who suggest that informal microenterprise success rates (measured by employment of others) are about 7% in the developing world. Grimm et al. (2012) argue in their study of the informal economy in West Africa that constrained gazelles are more likely to come from dynamic economies; dynamism as a whole is lacking within the Nicaraguan context.

Nonetheless, this healthy group of extraordinary performing informal *tienditas* representing both rural and urban areas and all but one of the regions of Nicaragua may be positioned for rapid growth provided the correct institutional interventions, such as access to capital through financial institutions and overseas remittances, relaxed legal requirements for formal sector entry, and bookkeeping training (where only seven in this group kept business records). Calderon et al. (2016) advocate similar policy interventions such as management training for those informal female Mexican entrepreneurs identified with the greatest success potential.

On the other end of the performance continuum, perhaps there is little direct public assistance that may help failing *tienditas* become stable or healthy business concerns. In many respects, failing *tienditas* fit the narrative of informal female entrepreneurship espoused by Nichter and Goldmark (2009) and uncovered by Grimm et al (2012) in West Africa. Yet, on the one hand, failing *tienditas* may provide some income to avoid complete familial disaster; however, on the other hand, the risk of utilizing scare public resources to assist failing *tienditas* does not seem to match the business outlook of such microenterprises that are operating at the edge of extreme poverty. Perhaps this is an area where private or not-for-profit organizations may step in with microcredit assistance (Pisani, 2010). As a whole, failing *tienditas* comprise 30.4% of all *tienditas* while nationally 7.6% of households live in extreme poverty (FIDEG, 2013). The challenges of extreme poverty are embedded within structural deficiencies of institutions. Hence, structural changes, such as paid access to education for longer periods in high achieving schools (like Mexico's *oportunidades* program), may be a much better use of scarce public resources for children in households involved in failing *tienditas*.

Perhaps it is with ailing and stable *tienditas* that public policy may have the greatest impacts on these primarily necessity-driven microenterprises. For about one in three ailing firms, the practice of keeping business records enhances earnings significantly—that is, ailing firms with bookkeeping in place outperform their ailing firm counterparts by more than thirty percent on a per hour earnings basis. Basic business bookkeeping and accounting is an acquired skill that may be transferred to *tendera* entrepreneurs through skill development workshops in local schools at night with a modest investment. Yet not all *tenderas* in this segment may be ready to receive such training as 18.9% report they are not literate and 32.4% report having three years of formal education or less. In such cases family members, especially children with higher levels of education, may assist with the training and maintenance of record keeping in the *tiendita*. More concerted public investments in adult education for those whom the educational system has passed by may reap positive spillovers across the micro-entrepreneurship class. Moving ailing

*tienditas* that are marginally subsistence in outcome toward stability may radically improve life chances, particularly for the children of *tenderas*.

Stable *tienditas* provide a sufficient household income base for survival. Importantly, *tenderas* operating stable *tienditas* have a solid foundation to move forward. Nearly all are literate and 74.3% possess four years or more of formal education. As such, public policy interventions involving education and training, like bookkeeping, are very likely to take hold with this segment of *tiendita* owners. Further, remittances for owners of stable *tienditas* significantly boost earnings. There are no restrictions or taxes to remittance flows into Nicaragua (Deloitte, 2016), though there are very low rates of penetration of the formal financial sector particularly for those at the economic margins of society[9]. Policies that expand the banked population in Nicaragua may facilitate the over $1billion in inbound remittance flows (IMF, 2013) and ease access to native capital and financial institutions. Additionally, relaxed regulatory policies may move stable, but informal, *tienditas* toward formal incorporation as long as the benefits of formality outweigh the costs of formality (Prahalad, 2004).

For three of four *tiendita* segments and *tienditas* collectively, regional location in Managua augmented earnings. This expected finding primarily results from Managua's status as the economic hub of the country. Business location, especially as it is home-based and typically at the economic periphery, is not easily transferred in this context. Hence there is little public policy may achieve connecting regional business location in Managua and *tiendita* earnings. Indeed, as a classic primate city, Managua may be better off if the rural to urban migration to the capital is reduced where the present infrastructure is overburdened. More salient is the finding that the more *tenderas* worked in their *tienditas* the lower their economic returns per hour. In part, longer hours may result in more income, but at a lower hourly return. This findings signals the lower opportunity costs associated with *tiendita* ownership where next best occupational choices are found in second job employment such as raising animals, small scale vending, cooking, baking, sewing, and washing clothes for others. Nevertheless, *tiendita* ownership may provide an important path toward poverty reduction for some where economic opportunities are limited at the BoP particularly for adult women whom the educational system has passed by.

[9] Of the poorest 40% of households in Nicaragua, only 8% have a bank account. For the nation as a whole, 19% of adults possess a bank account (Demirguc-Kunt et al., 2015). The World Bank considers the overall volume of remittances to be large as remittances amount to 10% of GDP and 23% of the value of goods and services exports (Demirguc-Kunt et al., 2015).

## 5. Conclusion

*Tienditas*, in-home convenience stores, are ubiquitous in Nicaragua where the total number of *tienditas* may exceed 100,000 firms employing 200,000 Nicaraguans. This is not an inconsequential business sector. Indeed more than half of Nicaraguans shop frequently at *tienditas*, more so in rural areas and in the urban periphery reaching base of the pyramid consumers. In meeting this consumer market niche, *tienditas* fulfill a Kirznerian or incremental market approach (and market need) toward micro-entrepreneurship.

Recently, Nichter and Goldmark (2009) advanced our understanding of the structural challenges and opportunities facing micro and small enterprises (MSEs) in the developing world. They lumped together the most challenged businesses as firms (and households) on the margins of life, literally interpreted. Nichter and Goldmark (2009) found that the *most* disadvantaged firms happen to be those MSEs that are female-owned, informal, and home-based within developing country economic contexts. This description matches *tendera* operated *tienditas* in Nicaragua. No *tiendita* in the survey reported enrollment in social security, a signal of informality. And by definition, only storefronts embedded within households were selected for analysis; hence in a classic sense, Nicaraguan female *tenderas* match Nichter and Goldmark's description of a disadvantaged and survivalist firm— where average business income falls under $3 per day. Yet, business income from *tiendita* ownership is relatively stable and resilient to seasonality in the region, another benefit of *tiendita* ownership (Pisani and Yoskowitz, 2012). *Tienditas*, however, are not homogenous and not all are disadvantaged; four earnings categories emerge: failing *tienditas* (under $1 a day), ailing *tienditas* ($1 to $2 a day), stable *tienditas* ($2 to $4 a day) and healthy *tienditas* (more than $4 dollars a day). While it may be beyond the state's ability to effectively assist failing *tienditas*, public policy innovations, such as easing access to credit and overseas remittances, providing bookkeeping skills, and legitimizing informal concerns, may help heal ailing *tienditas* and facilitate stable and healthy *tienditas* to perform even better. In all, national public policy may play an important role in a comprehensive approach toward poverty mitigation at the base of the pyramid.

Additionally, *tenderas* are limited in educational achievement where nearly one-fifth has never attended school and collectively 63% possess an elementary school education or less. As the average *tendera* is middle-aged and married, the possibility of acquiring additional formal education is highly improbable in a developing market context. Within this disadvantaged environment, the good news surrounds the economic returns to entrepreneurship even where the educational system and accompanying

opportunities have passed *tenderas* by. In a country where 75% earn $2 a day or less, more than half of *tenderas* earn above this perilous benchmark. Additionally, the workers in *tienditas*, who are mostly family members, have a much higher rate of educational achievement than *tenderas* suggesting that the children and extended family members of *tendera* households have the ability to pursue greater levels of education— where greater levels of education translate into higher paying work and life chances. Even so, about one-third of *tenderas* desire a change of occupational scenery hoping that another job would be higher paying. Second occupations for those *tenderas* who have them suggest few viable alternatives for higher paying work; in essence, many *tenderas* are doing relatively well considering their occupational alternatives.

Self-employed *tenderas* play an important role at the BoP, not only serving BoP consumers, but also achieving for many some modicum of relative good fortune for themselves and households given the available alternatives. Disadvantages aside, work as a *tendera* may be as good a self-employment option as possible for adult women to reduce poverty and move beyond survival at the BoP in a challenging emerging market like Nicaragua.

## References

Achua, C. F., and Lussier, R. N. (2014). "Entrepreneurial Drive and the Informal Economy in Cameroon". *Journal of Developmental Entrepreneurship*, 19, 1-12.

Adom, K. (2015). "Recognizing the Contribution of Female Entrepreneurs in Economic Development in Sub-Saharan Africa: Some Evidence from Ghana". *Journal of Developmental Entrepreneurship*, 20, 1-24.

Banco Central de Nicaragua (2015). "Estado de la Economía y Perspectivas 2016" [State of the Economy and 2016 Outlook]. Available in: <http://www.bcn.gob.ni/divulgacion_prensa/economia/Estado_Economia_2016.pdf>.

Banco Central de Nicaragua (2013). "Nicaragua en Cifras – 2012" [Nicaragua in Figures]. Available in: <http://www.bcn.gob.ni/estadisticas/economicas_anuales/nicaragua_en_cifras/2012/Nicaragua_cifras_2012.pdf>.

Berner, E., Gomez, G. and Knorringa, P. (2012). "'Helping a Large Number of People Become a Little Less Poor': The Logic of Survival Entrepreneurs". *European Journal of Development Research,* 24, 382-396.

Blanchflower, D. G., and Oswald, A. J. (1998). "What Makes an Entrepreneur?". *Journal of Labor Economics,* 16, 26-60.

Calderon, G., Iacovone, L., and Juarez, L. (2016). "Opportunity versus Necessity: Understanding the Heterogeneity of Female Micro-Entrepreneurs". *World Bank Policy Research Working Paper No. 7636.*

Deloitte (2016). "International Tax: Nicaragua Highlights 2016". Available in: <http://www2.deloitte.com/content/dam/Deloitte/global/Documents/Tax/dttl-tax-nicaraguahighlights-2016.pdf>.

De Mel, S., McKenzie, D. J., and Woodruff, C. (2009). "Measuring Microenterprise Profits: Must We Ask How the Sausage Is Made?". *Journal of Development Economics,* 88, 19–31.

Demirguc-Kunt, A., Klapper, L., Singer, D., and Van Oudheusden, P. (2015). "The Global Findex Database 2014: Measuring Financial Inclusion around the World". *World Bank Policy Research Working Paper No. 7255.*

D'Haese, M., Van de Berg, M., and Speelman, S. (2008). "A Country-wide Study of Consumer Choice for an Emerging Supermarket Sector: A Case Study of Nicaragua". *Development Policy Review,* 26, 603-615.

FIDEG (2013). "Encuesta de Hogares para Medir la Pobreza en Nicaragua: Informe de Resultados 2012" [Household Survey to Measure Poverty in Nicaragua: Results Report 2012]. *Fundacíon Internacional para el Desafío Económico Global.* Nicaragua: FIDEG. Available in: <http://www.fideg.org/images/INFORME_DE_LA_ENCUESTA_DE_HOGARES_FIDEG_2012.pdf>.

Funkhouser, E. (1996). "The Urban Informal Sector in Central America: Household Survey Evidence". *World Development,* 24, 1731-1751.

Gindling, T. H., and Newhouse, D. (2012). "Self-employment in the Developing World". *World Bank Policy Research Working Paper No. 6201.*

Grimm, M., Knorringa, P., and Lay, J. (2012). "Constrained Gazelles: High Potentials in West Africa's Informal Economy". *World Development,* 40, 1352-1368.

Gurtoo, A., and Williams, C. C. (2009). "Entrepreneurship and the Informal Sector". *Entrepreneurship and Innovation,* 10, 55-62.

Haase, D. (2007). "Closing the Gender Gap". *ESR Review,* 9, 4-9.

Hart, K. (1970). "Small Scale Entrepreneurs in Ghana and Development Planning". *Journal of Development Planning,* 6, 104–120.

Hart, K. (1973). "Informal Income Opportunities and Urban Employment in Ghana". *Journal of Modern African Studies,* 11, 61–89.

Itzigsohn, J. (2000). *Developing Poverty: The State, Labor Market Deregulation, and the Informal Economy in Costa Rica and the Dominican Republic.* University Park, PA: The Pennsylvania State University Press.

IMF [International Monetary Fund] (2013). "Nicaragua: Staff Report for the 2013 Article IV Consultation – Debt Sustainability Analysis, November 14". Available in: <https://www.imf.org/external/pubs/ft/dsa/pdf/2013/dsacr13377.pdf>.

Jain, A., and Pisani, M. J. (2008). "Small and Microenterprise Business Development in Costa Rica: An Examination of Domestic and Foreign Born Entrepreneurs". *Latin American Business Review,* 9, 149-167.

Kampwirth, K. (2012). The Feminist Movement. In Close, D., I Puig, S. M. and McConnell, S. A. (Eds.), *The Sandinistas and Nicaragua Since 1979* (185-214). Boulder, CO: Lynne Rienner Publishers.

Khan, T., and Khan, R. E. A. (2009). "Urban Informal Sector: How Much Women Are Struggling for Family Survival". *The Pakistan Development Review,* 48, 67-95.

Kirzner, I. M. (1973). *Competition and Entrepreneurship.* Chicago, IL: University of Chicago Press.

Margolis, D. N. (2014). "By Choice and by Necessity: Entrepreneurship and Self-Employment in the Developing World". *European Journal of Development Research,* 26, 419-436.

Mead, D. C., and Liedholm, C. (1998). "The Dynamics of Micro and Small Enterprises in Developing Countries". *World Development,* 26, 61-74.

Nichter, S., and Goldmark, L. (2009). "Small Firm Growth in Developing Countries". *World Development,* 37, 1453-1464.

Peattie, L. (1987). "An Idea in Good Currency and How It Grew: The Informal Sector". *World Development,* 15, 851-860.

Pisani, M. J. (2017). Entrepreneurship at the Base of the Pyramid: The Case of Nicaragua. In Williams, C. C. and Gurtoo, A. (Eds.), *Handbook of Entrepreneurship in Developing Economies* (343-355). New York, NY: Routledge.

Pisani, M. J. (2013). Informal Entrepreneurship in Central America: A Labor of Love or Survival? In Thai, M. T. T. and Turkina, E. (Eds.), *Entrepreneurship in the Informal Economy: Models, Approaches and Perspectives for Economic Development* (127-142). New York, NY: Routledge.

Pisani, M. J. (2010). Is Microcredit Compatible with Micro-Entrepreneurship? Evidence from Latin American *Tienditas*. In Munoz, J. M. (Ed.),

*Contemporary Microenterprise: Concepts and Cases* (102-115). Northampton, MA: Edward Elgar Publishing.

Pisani, M. J. (2006). "Nicaraguan Self-Employed Women under Neoliberalism: Characteristics and Determinants". *Latin American Business Review*, 7, 89-106.

Pisani, M. J., and Pagán, J. A. (2004). "Self-Employment in the Era of the New Economic Model in Latin America: A Case Study from Nicaragua". *Entrepreneurship and Regional Development,* 16, 335-350.

Pisani, M. J., Richardson, C., and Patrick, J. M. (2008). "Economic Informality on the U.S.-Mexican Border: A (Re)View from South Texas". *Journal of Borderlands Studies,* 23, 19-40.

Pisani, M. J., and Yoskowitz, D. W. (2012). "A Study of Small Neighborhood *Tienditas* in Central America". *Latin American Research Review,* 47, 116-138.

Pisani, M. J., and Yoskowitz, D. W. (2010). "The Efficacy of Microfinance at the Sectoral Level: Urban *Pulperías* in Matagalpa, Nicaragua". *Perspectives on Global Development and Technology,* 9, 418-448.

Prahalad, C. K. (2004). *Fortune at the Bottom of the Pyramid: Eradicating Poverty through Profits.* Upper Saddle River, NJ: Prentice Hall.

Richardson, C., and Pisani, M. J. (2012). *The Informal and Underground Economy of the South Texas Border.* Austin, TX: University of Texas Press.

Stam, E., and van Stel, A. (2011). Types of Entrepreneurship and Economic Growth. In Szirmai, A., Naudé, W. and Goedhuys, M. (Eds.), *Entrepreneurship, Innovation, and Economic Development* (78-95). New York, NY: Oxford University Press.

Walker, T. W., and Wade, C. J. (2011). *Nicaragua: Living in the Shadow of the Eagle*. Fifth edition. Boulder, CO: Westview Press.

Williams, C. C. (2007). "Entrepreneurs Operating in the Informal Economy: Necessity or Opportunity Driven?". *Journal of Small Business and Entrepreneurship,* 20, 309-20.

Williams, C. C. (2008). "Beyond Necessity-driven Versus Opportunity-driven Entrepreneurship: A Study of Informal Entrepreneurs in England, Russia and Ukraine". *Entrepreneurship and Innovation,* 9, 157-65.

Williams, C. C., and Youssef, Y. (2013). "Evaluating the Gender Variations in Informal Sector Entrepreneurship: Some Lessons from Brazil". *Journal of Developmental Entrepreneurship,* 18, 1-16.

World Bank (2016). "Nicaragua". Available in: <http://data.worldbank.org/country/nicaragua>.

World Food Programme (2014). "Nicaragua". Available in: <http://www.wfp.org/countries/nicaragua>.

Xavier, S. R., Kelley, D., Kew, J., Herrington, M., and Vorderwülbecke, A. (2012). "Global Entrepreneurship Monitor 2012 Global Report". Available in: <http://www.gemconsortium.org/docs/download/2645>.

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