

# The Role of Honey Production in Economic Growth: Evidence from a Panel of Major Global Producers

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**Abstract:** This paper investigates the contribution of honey production to economic growth. Considering a sample of the major honey producers coming from the Americas, Eastern and European groups, as well as by taking advantage of panel methodological approaches, the empirical analysis documents that honey production could serve as an engine of growth. The results also highlight that the honey industry seems to stronger contribute to economic growth in the case of the Eastern group followed by the Americas and European groups.

**Keywords:** Honey Production, Economic Growth, Major Global Honey Producers, Panel Data

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## 1. Introduction

Agriculture plays a significant role in a sense that it can generate job opportunities, support rural development, and secure food production (Rephann, 2008). Overall, investment in agriculture is important for economic growth. Lack of investments in rural communities is a main reason for the chronic poverty in such rural areas (Duncan, 2005), while agricultural growth benefits the urban poor by reducing food prices (Byerlee, 2000). In addition, urbanization and its associated policies may decrease agricultural and other rural lands, thus, hindering agricultural production and environmental qualities (Rosenberger et al., 2002). Increasing the value of the product generated by agricultural enterprises through the construction of new linkages with markets, strengthens the rural agricultural economy (Banks and Marsden, 2000). Intensifying the research activity on the role of agricultural in the economic growth process is substantially crucial, because it helps to form both domestic and international policy decisions in relevance to how scarce resources are allocated to agricultural research and infrastructure (Tiffin and Irz, 2006). Nevertheless, the overall empirical literature has yielded mixed and sometimes conflicting evidence and there remains a lack of consensus on the effect of agriculture on economic growth. While a strand of the literature supports the presence of agricultural

development as a precondition to industrialization and economic growth (Thirtle et al., 2003), another strand disagrees (Schiff and Valdez, 1998; Yao, 2000).

Given the above discussion, as well as the fact that the demand for this natural product is increasing on a global scale (Berthe et al., 2013; Legesse, 2014), this paper explores, for the first time, the contribution of the honey industry to economic growth. Honey has certain applications in related to sugar industries. In addition, the pharmaceutical industry has assigned certain healing benefits in relevance to honey, including drugs production and healthcare facilities, although its healing capacity seems to exert a negative impact on diabetic patients. Nevertheless, the medical use of honey is expected to expand furthermore, and, thus, to generate new businesses in the relevant manufacturing industry. According to Paterson (2006), the honey industry is a sustainable form of agriculture that can provide people, mostly in rural areas, with a source of much-needed income and nutrition and with advanced apicultural skills and equipment. The technological evolution associated with this industry is also substantially significant (Krell, 1996).

In terms of certain statistics associated with the global honey industry (available from <http://faostat.fao.org/site/339/default.aspx>), the growth of global honey production seems to have concentrated on five major world regions: Latin America, North America, Europe, Asia-Pacific, and Middle East and Africa. More specifically,

the major producers and exporters of honey are: Argentina, Mexico, Brazil, Canada, Uruguay, Chile, Cuba (the Americas group), China, India, Vietnam, Ukraine, Thailand, Taiwan and Turkey (the Eastern group) and Germany, Spain, Hungary, France, Belgium and Greece (the European group). Major honey exporting countries of the Americas showed a slight increase of their beehives counts since 2007 (+ 3%), while their honey exports fell 9%, probably due to the increased production difficulties for beekeeping in this region. By contrast, the total number of beehives of the Eastern group grew 13%, while they increased their honey exports by 196%. China, with 9 million beehives, it is by far the world's largest honey producer and exporter. Its annual honey production is around 450,000 tons and domestic consumption seems to be much larger than its production capacity. The Chinese consumer attributes important health benefits to this natural product. The gap between [consumption+ export] and [production + import] seems to be covered by dilution with syrups (Phipps, 2016). China has also been the number one honey exporter in the world, dominating 12% of the global honey sales. Germany has been the second largest producer and exporter followed by Mexico. Based on the merit of the honey industry for the overall economic performance of the economy of main producers and exporters, our study empirically investigates the association of the volume of honey production with economic growth by using a panel data set of the major global producers, spanning the period 1990-2016.

## 2. Data and Methodology

Annual data on the value of honey production, measured in US dollars, are obtained for Argentina, Mexico, Brazil, Canada, Uruguay, Chile, Cuba, China, India, Vietnam, Ukraine, Thailand, Taiwan and Turkey, spanning the period 1990-2016. Data were retrieved from the Food and Agriculture Organization of the United Nations. Annual data on real GDP (at 2010 constant prices) are obtained from Datastream and measured in US dollars. Moreover, based on both neoclassical and endogenous growth theories, the analysis considers a number of control variables that could drive economic growth, such as:

1. gross capital formation (Young, 1991),
2. the labor force (Azariadis and Drazen, 1990; Klenow and Rodriguez-Clare, 1997), measured as the total number of workers in the economy,
3. (secondary) school enrollment as a proxy for human capital (Rebelo, 1991),
4. budget deficits/surpluses as percentage of GDP (Barro, 1990; Gomez, 2007), and
5. trade openness (Frankel and Romer, 1999; Karras, 2008), measured as the ratio of the sum of imports and exports to GDP. Data on these controls are also obtained from Datastream.

In terms of methodology, the empirical part of the paper first, makes use of the cross-sectional dependence (CD) statistic by Pesaran (2004), which is based on a simple

average of all pair-wise correlation coefficients of the OLS residuals obtained from standard augmented Dickey-Fuller regressions for each variable in the panel. Under the null hypothesis of cross-sectional independence, the CD test statistic follows asymptotically a two-tailed standard normal distribution. The CD test is given by:

$$CD = \sqrt{[2T/2N(N-1)]} \sqrt{\sum_{i=1}^{N-1} \sum_{j=i+1}^N \rho_{ij}}$$

where T denotes the number of observations, N is the number of pairs and  $\rho_{ij}$  denotes the average of pair-wise correlation coefficients.

Next, the analysis makes use of a second-generation panel unit root test to determine the degree (order) of integration in the respective variables. The Pesaran (2007) panel unit root test (known also as "CIPS" test) does not require the estimation of factor loading to eliminate cross-sectional dependence. Specifically, the usual Dickey-Fuller regression is augmented to include the lagged cross-sectional mean and its first difference to capture the cross-sectional dependence that arises through a single-factor model. The null hypothesis is a unit root for the Pesaran (2007) test. The test yields:

$$CIPS(N, T) = \frac{1}{N} \sum_{i=1}^N t_i(N, T)$$

where N is again the number of pairs in the panel set and T denotes the number of observations, with  $t_i(N, T)$  being the t-statistic of the OLS estimate of  $\rho$ , which is the correlation coefficient between the current and the lagged values in the Augmented Dickey-Fuller statistic.

In the next step, the empirical analysis considers the panel cointegration methodological approach to investigate the long-run equilibrium across the variables under study. Under the presence of cross-sectional dependence, the study makes use of the Durbin-Hausman test, recommended by Westerlund (2008), to explore the presence of cointegration. This test allows for cross-sectional dependence, modelled by a factor model in which the errors in the relevant regression are obtained by idiosyncratic innovations and unobservable factors that are common across units of the panel (Auteri and Constantini, 2005). The Durbin-Hausman test allows the stability ranks of the independent variables to be different, i.e. of any stationarity degree. Additionally, the test can be used only when the cross-sectional dependence is available. Two tests are calculated, i.e. one panel and one group. The panel statistics infer results for the panel in general, while the group statistics infer results for the individuals that make up the panel. In the Durbin-Hausman test, it is assumed that the residuals' (z) distribution adapted according to the equations below to allow for cross-sectional dependence:

$$z_{it} = \lambda'_i F_t + e_{it}$$

$$F_{jt} = p_j F_{j,t-1} + u_{jt}$$

$$e_{it} = \varphi_i e_{it-1} + v_{it}$$

with  $p_j < 1$  for all  $j$ s.

with  $F_t$  being the  $k$ -sized vector of the  $F_{jt}$  common factor and  $\lambda_i$  being the vector of factor loadings. To generate the Durbin-Hausman test, the difference of the  $z_{it}$  equation is taken:  $\Delta z_{it} = \lambda_i' \Delta F_t + \Delta e_{it}$ . Given that  $\Delta z_{it}$  is unknown, a principal component estimator must be used. The  $z_{it}$  equation principal component can be written as:

$$\Delta z_{it} = \Delta y_{it} - \beta_i \Delta x_{it}$$

which represent the residuals from the cointegrating vector. The  $\Delta F_t$ , which is the principal component estimator, can be obtained by calculating the eigenvector  $\sqrt{T-1}$  times among the greatest eigen value of the  $(T-1)(T-1)$  matrix, with  $\lambda$  being calculated as:  $\Delta F' \Delta z / (T-1)$ . The null hypothesis, which expresses that there is no co-integration is the asymptotic equation that tests whether  $\varphi_i = 1$  in the regression:  $e_{it} = \varphi_i e_{it-1} + \text{error}$ . After these calculations, the Durbin-Hausman test is calculated with the two versions of the formula below:

$$DH_g = \sum_{i=1}^n S_i (\varphi_{1i} - \varphi_i) \sum_{t=2}^T e_{it-1}$$

and

$$DH_p = (\varphi_{1i} - \varphi_i)^2 \sum_{i=1}^n \sum_{t=2}^T e_{it-1}$$

where  $DH_p$  expresses the panel statistic and  $DH_g$  expresses the group statistic, respectively.

Finally, the analysis applies a panel methodology which takes into account cross-section and time dimensions of the data, as well as cross dependence, to estimate the long run relationship under consideration. When the errors of a panel regression are cross-sectionally correlated then standard estimation methods can lead to inconsistent estimates and incorrect inference (Phillips and Sul, 2003). In order to take into account the cross-sectional dependence we implement a novel econometric methodology, namely, the Common Correlated Effects (CCE) by Pesaran (2006). He suggests a new approach to estimation that takes into account cross sectional dependence. The proposed methodology allows individual specific errors to be serially correlated and heteroskedastic. In a series of Monte Carlo experiments, Pesaran (2006) and Kapetanios et al. (2011) show that the CCE estimators have the correct size, and in general have better small-sample properties than alternatives that are available in the literature. Furthermore, they have shown that small-sample properties of the CCE estimators do not seem to be much affected by the residual serial correlation of the errors. To obtain the long-run estimates, Pesaran (2006) adopts a multifactor residual model, such as:

$$y_{it} = \alpha_i + \beta_i x_{it} + \varepsilon_{it}$$

$$\varepsilon_{it} = \lambda_i' F_t + u_{it}$$

where subscript  $i$  is the  $i$ th cross section observation at time  $t$ , for  $t=1, 2, \dots, T$  and  $i=1, 2, \dots, N$ .  $F_t$  is the  $m \times 1$  vector of unobserved common factors. Pesaran (2006) considers the case of weakly stationary factors. However, Kapetanios et al. (2011) show that Pesaran's CCE approach continues to yield consistent estimation and valid inference even when common factors are unit root processes (I(1)). To deal with the residual cross section dependence Pesaran (2006) uses cross sectional averages, which can be consistently estimated within the following auxiliary regression:

$$y_{it} = \alpha_j + \beta_j x_{it} + e_{it}$$

with a bar denoting the average value. Pesaran (2006) refers to the resulting OLS estimators  $\hat{B}_{j,CCE}$  of the individual specific slope coefficients  $B_j = (\beta_j)'$ , as the 'Common Correlated Effect' (CCE) estimators:

$$\hat{B}_{j,CCE} = (X_j' \bar{D} X_j) X_j' \bar{D} E_j,$$

where:  $X_j = (x_{j1}, x_{j2}, \dots, x_{jT})'$ ,  $x_{jt} = (Y_{jt}, Y_{jt}^2)'$ ,  $E_j = (E_{j1}, E_{j2}, \dots, E_{jT})'$ ,  $\bar{D} = I_T - \bar{H}(\bar{H}'\bar{H})^{-1}\bar{H}$ ,  $\bar{H} = (h_1, h_2, \dots, h_T)'$ , and  $h_t = (1, y_t, x_t)$  as the 'Common Correlated Effect' (CCE) estimators. The 'Common Correlated Effects Mean Group' (CCEMG) estimator is the average of the individual CCE estimators  $\hat{B}_{j,CCE}$ :

$$\hat{B}_{CCEMG} = \sum_{j=1}^N \hat{B}_{j,CCE}$$

The new CCEMG estimator follows asymptotically the standard normal distribution. Specifically:

$$\sqrt{N}(\hat{B}_{CCEMG} - B) \xrightarrow{d} N(0, \Sigma_{MG})$$

In a series of Monte Carlo experiments, Pesaran (2006) and Kapetanios et al. (2011) show that the CCE estimators have the correct size, and in general have better small-sample properties than alternatives that are available in the literature. Furthermore, they have shown that small-sample properties of the CCE estimators do not seem to be much affected by the residual serial correlation of the errors.

### 3. Results and Discussion

In the first step of empirical analysis, we examine the unit root properties in the data through advanced panel unit root tests. Panel unit root tests of the first-generation can lead to spurious results (because of size distortions), if significant degrees of positive residual cross-section dependence exist and are ignored. Consequently, the implementation of second-generation panel unit root tests is desirable only when it has been established that the panel is subject to a significant degree of residual cross-section dependence. In the cases where cross-section dependence is not sufficiently high, a loss of power might result if second-generation panel unit root tests that allow for cross-section dependence are

employed. Therefore, before selecting the appropriate panel unit root test, it is crucial to provide some evidence on the degree of residual cross-section dependence.

The results of the CD testing procedure are reported in Table 1 and they uniformly reject the null hypothesis of cross-section independence, providing evidence of cross-sectional dependence in the data given the statistical significance of the CD statistics regardless of the number of lags (from 1 to 4) included in the ADF regressions.

Table 1. Cross Dependence Tests.

Lags				
Variables	1	2	3	4
Honey production	[0.00]***	[0.00]***	[0.01]***	[0.02]**
Real GDP	[0.00]***	[0.00]***	[0.00]***	[0.00]***
Labor force	[0.00]***	[0.00]***	[0.00]***	[0.01]***
Gross capital formation	[0.00]***	[0.00]***	[0.00]***	[0.00]***
School enrolment	[0.00]***	[0.00]***	[0.01]***	[0.02]**
Public deficit	[0.00]***	[0.00]***	[0.00]***	[0.00]***
Trade openness	[0.00]***	[0.00]***	[0.00]***	[0.01]***

Notes: Under the null hypothesis of cross-sectional independence the CD statistic is distributed as a two-tailed standard normal. Results are based on the test of Pesaran (2004). Figures in parentheses denote p-values. \*\*\*: p≤0.01, \*\*: p≤0.05.

Next, the results of the panel unit root test are reported in Table 2 and support the presence of a unit root in both variables under consideration. In other words, our sample variables are integrated of order one I(1).

Table 2. Panel Unit Root Tests.

Variable	Pesaran (CIPS)	Pesaran (CIPS*)
Honey production	-1.33	-1.42
ΔHoney production	-6.19***	-6.38***
Real GDP	-1.29	-1.45
Δreal GDP	-6.38***	-6.64***
Labor force	-1.25	-1.36
Δlabor force	-6.33***	-6.45***
Gross capital formation	-1.30	-1.42
Δgross capital formation	-6.24***	-6.35***
Public deficit	-1.31	-1.39
Δpublic deficit	-6.28***	-6.36***
School enrollment	-1.38	-1.45
Δschool enrollment	-5.95***	-6.17***
Trade openness	-1.31	-1.44
ΔTrade openness	-5.71***	-6.09***

Notes: Δ denotes first differences. A constant is included in the Pesaran (2007) tests. Rejection of the null hypothesis indicates stationarity in at least one country. CIPS\* = truncated CIPS test. Critical values for the Pesaran (2007) test are -2.40 at 1%, -2.22 at 5%, and -2.14 at 10%, respectively. The results are reported at lag = 4. The null hypothesis is that of a unit root. \*\*\*: p≤0.01.

The results of the panel cointegration tests are reported in Table 3. These findings clearly illustrate that the null hypothesis of no-cointegration is rejected at the 1% significance level for both tests, indicating that there exists a significant long-run equilibrium among economic growth, honey production, and the remaining control variables, such as labor force, gross capital formation, public deficit as percentage of GDP, secondary school enrolment, and trade

openness in our countries sample.

Table 3. Westerlund's Cointegration Tests (Full Sample).

DH <sub>g</sub>	7.928[0.00]***
DH <sub>p</sub>	9.652[0.00]***

Notes: p-values are reported in brackets. The criterion used in this paper is IC<sub>2</sub>(K) with the Maximum number of factors (K) set equal to 5. For the bandwidth selection, M was chosen to represent the largest integer less than 4(T/100)<sup>2/9</sup>, as suggested by Newey and West (1994). \*\*\*: p≤0.01 and indicates the rejection of no co-integration null hypothesis.

The results of the CCE (long-run) estimates are reported in Table 4, with the variables of real GDP, honey production, labor force, gross capital formation and secondary school enrolment being expressed in logarithms. The findings highlight a positive and statistically significant honey production effect, indicating that higher honey production by 1 percent leads to a 0.23 percent increase in real GDP. The remaining control variables seem to carry the expected theoretical sign in relevance to their impact on economic growth, while they are all statically significant.

Table 4. Common Correlated Effects (CCE) Long-Run Estimates: The Dependent Variable is Real Economic Growth (Full Sample).

variables	coefficient	t-statistic	p-value
constant	1.135	3.472	0.01
honey production	0.234	7.859	0.00
labor force	0.286	5.984	0.00
gross capital formation	0.527	6.810	0.00
public deficit ratio	0.472	6.473	0.00
school enrolment	0.486	6.915	0.00
trade openness	0.509	7.952	0.00
Adjusted R-squared	0.73		

In this part of the empirical analysis we explore the role of the geographic factor with respect to the economic growth-honey production nexus by splitting our country sample into the Americas, Eastern and European groups. Table 5 reports the three panel groups cointegration tests, where in all three cases the findings reject the null hypothesis of no cointegration.

Table 5. Westerlund's Cointegration Tests (Country Groups).

Americas group	
DH <sub>g</sub>	6.256[0.00]***
DH <sub>p</sub>	8.274[0.00]***
Eastern group	
DH <sub>g</sub>	9.673[0.00]***
DH <sub>p</sub>	11.503[0.00]***
European group	
DH <sub>g</sub>	6.135[0.00]***
DH <sub>p</sub>	7.628[0.00]***

Notes: p-values are reported in brackets. The criterion used in this paper is IC<sub>2</sub>(K) with the Maximum number of factors (K) set equal to 5. For the bandwidth selection, M was chosen to represent the largest integer less than 4(T/100)<sup>2/9</sup>, as suggested by Newey and West (1994). \*\*\*: p≤0.01 and indicates the rejection of no co-integration null hypothesis.

Finally, Table 6 offers the CCE panel estimates in relevance to the three groups. The new findings illustrate that although in all three groups the effect of honey production on

economic growth turns out to be positive and statistically significant, the impact gets stronger in the case of the Eastern group, followed by the Americas and the European groups, with coefficient estimates 0.26, 0.19 and 0.17, respectively. In terms of the remaining control variables of economic growth, their estimates retain the expected theoretical sign and effect on economic growth.

**Table 6.** Common Correlated Effects (CCE) Long-Run Estimates: Dependent Variable is Real Economic Growth (Country Groups).

Variables	Americas group	Eastern group	European group
constant	0.8561.972	0.693	
	[0.02]	[0.01]	[0.02]
honey production 0.193	0.261	0.171	
	[0.00]	[0.00]	[0.00]
labor force	0.227	0.315	0.259
	[0.00]	[0.00]	[0.00]
gross capital formation	0.591	0.362	0.415
	[0.00]	[0.00]	[0.00]
public deficit ratio	0.539	0.238	0.486
	[0.00]	[0.00]	[0.00]
school enrolment	0.593	0.438	0.488
	[0.00]	[0.00]	[0.00]
trade openness	0.391	0.584	0.424
	[0.00]	[0.00]	[0.00]
Adjusted R-squared	0.65	0.77	0.61

Note: Figures in brackets denote p-values.

## 4. Conclusion

This study explored, for the first time, the role of honey production in the process of economic growth, by employing data on both honey production and real GDP, as well as on a number of economic drivers of growth obtained from the major global producers and exporters. Panel methodological approaches offered findings that highlighted the substantial and statically significant impact of honey production on economic growth. The results got stronger for the case of the Eastern group of producers and exporters, followed by those in the cases of the Americas and European groups, indicating the strong dynamics of the honey industry in the case of Eastern countries, in terms of investments and job creation in these countries.

Hence, the honey industry has the potential of giving people opportunities for reliable income generation either through exporting or through job creation. The sector could also have positive spillovers through the provision of major inputs for the development of allied industries, like the brewery and pharmaceutical industries and improve environmental conservation. There are prospects for the sector to complement other efforts to enhance people's standard of living. When effectively supported, the honey industry could be one of the pillars for reducing poverty and economic vulnerability, especially in low income countries or in low-income regions, a topic for which future research activities could be intensified.

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