Original Article

Examining the Effects of R&D and Human Capital on Export of Iran

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ABSTRACT: Export for any country as the driving force of the economy, is a factor for progress and has many advantages. Export also acts as a channel for technology transfer and knowledge to differentiate products and improve product design ideas. This is an important economic factor, which provides opportunities for the exploitation of successful researches, and increases the incentives for investment in R&D and encourages technical innovation and the development of markets. For this purpose, this study tries to investigate the effects of R&D and human capital on export of Iran in the 1975-2012 period using OLS methods. The results show that R&D has a significant and positive effect on export, so by 1 percent increase of R&D, export increased 0/33 percent. Also, human capital has a positive impact on export. It can be said that by 1 percent increase in the human capital, export increased 0/58 percent.

KEYWORDS: R&D, Human Capital, Export, OLS.

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1. INTRODUCTION

In today's world, communication, exchange of goods, information and technology have expanded and improved, more than ever. Manufacturers and exporters of goods have a better chance to compete in the international market than in the past, and by this way, expand the scope of its activities. The most traditional way to enter this market, is the export of goods, which makes more and more progress, more income and continuous notification of the latest developments in technology and knowledge, rather than the past (Ulku, 2005, 27). Raising export power to increase domestic production, employment and value added in various fields (agriculture, industry, mining, etc.) to improve the quality of products and creating competition, due to the possibility of more and better products and the balance of payments of countries (Madsen, 2008, 3).The issue of export, is considered as one of the most important economic issues in most developing countries. Exports of each country, including economic indicators show the relationship between countries with the world economy. Export is the driving force of economic development. This economic factor has countless benefits. Creating revenues to finance import needs of the country, economic development programs, job creation, Improving the quality of manufactured goods and Lowering the production cost due to the utilization of full production capacity are, including of these benefits(Teixeira and Fortuna, 2004). With the encouragement of export domestic production is carried out, for the growth and prosperity through trade in international competition. According to this view, free trade, through the static and dynamic benefits, ultimately, will increase the productivity and welfare of the economy (Van Den Breg, 2001, 23).

Recent studies have shown that the only countries that could be involved in the initiation in this sector who have planned and organized, with attention to long-term socio-economic objectives, have certain programs (Konya, 2006, 979). Obviously, to adopt appropriate policies in this area, it is necessary to identify the more precisely export. Several factors can have an influence on the exports of each country, it can be noted that the human capital, research and development and the degree of openness are some of these factors. Therefore, this study attempts to examine the effects of the above variables on behaviour of exports of Iran, using ordinary least square models in the period 1975-2012.

2. LITERATURE REVIEW

Blanchard and Olney (2015) examined the globalization and investment in human capital and its effects on economic growth using a panel of 102 countries and 45 years. They find that growth in less skill-intensive exports depresses average educational attainment while growth in skill-intensive exports increases schooling. Results provide insight into which types of sectoral growth are most beneficial for long-run human capital formation and suggest that trade liberalization could exacerbate initial differences in factor endowments across countries.

Heath and Mobarak (2015) have studied the effects of new employment opportunities in the ready garment industry on women's schooling, work, marriage and fertility decisions in a poor country. They have found out that manufacturing sector growth in Bangladesh had sizeable effects on parents' propensity to keep younger girls in school, older girls' propensity to engage in wage work, and both of these factors allowed women to postpone marriage and childbirth.

Oster and Steinberg (2013) in a study used microdata to evaluate the impact of high-skill jobs on local school enrolment in areas outside of major IT centres. They merge panel data on school enrolment from a comprehensive school-level administrative dataset with detailed data on Information Technology Enabled Services (ITES) centre location and founding dates. They find compelling evidence that school enrolments in India increased with local IT jobs.

Atkin (2012) examined the endogenous skill acquisition and export manufacturing in Mexico in the 1986-2000. The results showed that expanded export-sector job opportunities caused an increase in the high school drop-out rate during the period of rapid trade liberalization from 1986 and 2000.

Hickman and Olney (2011) examined the impact of globalization on the domestic labour market for low-skilled workers. Whereas existing research typically focuses on the effects on labour market outcomes such as wages and employment, they are examining whether American workers respond to globalization by increasing their investment in human capital or not. Using both Census data and the Integrated Postsecondary Education Data System (IPEDS) for the period 2000–2007, they measure the extent to which offshoring and immigration affect enrolment at institutions of higher education. Results indicate that both offshoring and immigration increase enrolment at community colleges but not at other types of institutions, particularly among older, non-traditional age students.

Vogiatzoglou (2009) investigated the determinants of exports of ICT in the country during 2000-2006. The results of the study show that the costs of research and development and human capital have significant positive effect on exports of information and communication technologies in the country.

Munch and Skaksen (2008) examined the relationship between education level of corporate employees, wage employment and export performance in Denmark during the period 1995-2002. They showed that firms with higher education and skill levels of their employees are capable of producing diversified products and quality, maintain its position in international competition. The results also showed that a positive interaction between exports and education levels that leads to a positive effect on the wages of employees in companies'.

Dulleck and Foster (2008) in an article entitled "The imported equipment, human capital and economic growth in developing countries," paid the effect of the imported equipment on the growth of developing countries and also between human capital and investments in equipment. The results show that the relationship between the imported capital equipment growths for countries with low levels of human capital is often negative.

Aysan and Selim (2007) using panel data have examined the determinants of export growth over the period 1996-2006 to 22 sectors of Turkish industry. In this study, the variables affecting the exports were: labour, labour productivity, global income and consumer price index. The results showed that education is one of the most important factors affecting exports.

Chen and Gupta (2006) in the article, examined the interaction between the degree of economic openness and human capital in 20 African countries over the period 1990 to 2003, using panel data. According to the results, the effect is negative and there is a significant crossover between education and economic openness.

Herzer (2005) has studied the impact of exports of manufactured goods, exports of raw materials and imports of capital goods on economic growth in the China over the period 1960–2001. The results show that industrial exports and imports of capital lead to the spread of knowledge, science and advanced technology, improve the productivity of factors of production and has created a significant and positive impact on economic growth, but exports of raw materials had no significant effect on economic growth.

Lopez and Serrano (2005) have examined the effects of human capital and foreign trade on the productivity of factors of production In 17 different regions of Spain through panel data. During the period 1996- 1980 estimated results show that human capital and foreign trade had a

significant positive impact on the level and productivity growth which have been created, but their impact on the rate of productivity growth had been higher.

Rodwell and Teo (2003) in the study investigated the impact of human capital accumulation and management of Australia's exports of light industry. Their results showed that the accumulation of knowledge is considered essential for the development of Australia's exports.

3. THEORETICAL FRAMEWORK AND PREVIOUS STUDIES

Exports are the driving force of economic development and have numerous advantages, so that it can be used for generating revenues to meet the import needs of the country or economic development programs, the creation of employment or new job opportunities, improving the quality of manufactured goods, lowering production costs due to the utilization of full production capacity and gaining international prestige strengthening economic foundation (Pourebrahim and Esmaeeli, 2010, 447).

It should be noted by encouraging exports, domestic production growth and prosperity through international trade is done in competition and according to this view, free trade through static and dynamic benefits, ultimately, causes increased production levels and economic well-being (Azimi, 2000, 56). Also, exports also acts as a channel for technology transfer and knowledge to differentiate products and improve product design ideas. Export, provides opportunities for exploitation of research successes, increase the stimulus-investment in R&D and encourage the technical innovation, the development of markets (Grossman and Helpman, 1991, 43-62). The effect of exports on productivity in business growth strategies, has been emphasized outward orientation (Ha and howitt, 2007, 739).

Export is an easy way to introduce new technology and management skills in the domestic economy that can have a positive impact on productivity growth. Competition from exports could also lead to more work for companies that do export to companies that are active only in the domestic market. Because they do not have the relationship with foreign companies. Although the outward orientation trade policies emphasize the importance of exports for growth (Guellec and De la Potterie, 2004, 353-360).

Today, R&D is the key to competitiveness and access to modern technology in the world and plays a major role in innovation, increase productivity and improve economic growth. One of the strategies that lead to the stability of institutions, strengthening the power of innovation to create and use advanced technology to produce products and do more to meet the needs of the community. Economists believe that science and technology as an effective and strong tool, can play an important role in the development process (Hunt and Nakamura, 2007).

In today's world, developed countries are among the countries that have high levels of science and technology. Therefore, many of the products, methods, tools and technologies advanced, due to the development and progress of this country in science and technology (Bazdar, 2011, 117). In recent decades, we have seen a dramatic increase in the role of knowledge and innovation in economic activities at the international level because Innovation is the most important aspect of knowledge creation (Collinsin, 2000, 218). Innovation is the process of translating knowledge into economic growth and social improvement and includes a set of scientific, technological, organizational, financial and commercial activities. Innovation in the introduction and commercialization of new products or services or significant improvement in the use of products and services, introduce new production processes or significant improvement in existing processes, opening new markets and developing new sources of supply, such as raw materials, equipment and other industrial inputs and fundamental changes in the structure and organization will appear in the communities and plays the decisive role in

economic development (Puga and Trefler, 2010, 66). It can be said that human capital determines the capacity of countries in the development of appropriate techniques of production and innovation activities and has a determining role in implementing and attracting foreign R&D activities (Zachariadis, 2004, 427). In addition to R&D role on innovation activities should be noted that on the one hand because of the accelerated process of global economic integration and on the other hand, due to the rapid growth of the publication and distribution of knowledge and technology, it is essential for developing countries to fill the technology gap and per capita income of developed countries in addition to domestic innovation, pay attention to diffusion and international technology spill-overs (Shahabadi and Havaej, 2011, 2). R&D process, including the identification of needs or talents, the emergence of ideas, creation, design, production, introduction and dissemination of new technological system is a product and process (Faramarzpour and Khandan, 2009). World Bank (2010) has divided indicators into three groups related to development economic policies, science and technology and education. These factors include GDP, GDP per capita, an annual growth of GDP, the added value of the industry, agriculture, the number of scientific and technical papers, the share of R&D of GDP, the number of researchers per million inhabitants, the income from the export of advanced technology products, and the costs of public education (Zabihi and Zavvari, 2011, 4). In this study we used the added value of the industrial sector as an indicator of R&D.

3. ESTIMATION METHODS

3.1. OLS methods

Ordinary Least Squares or OLS is one of the simplest methods of linear regression. The goal of OLS is to closely "fit" a function with the data. It does so by minimizing the sum of squared errors from the data. In statistics, ordinary least squares (OLS) or linear least squares is a method for estimating the unknown parameters in a linear regression model, with the goal of minimizing the differences between the observed responses in some arbitrary dataset and the responses predicted by the linear approximation of the data (visually this is seen as the sum of the vertical distances between each data point in the set and the corresponding point on the regression line - the smaller the differences, the better the model fits the data). The resulting estimator can be expressed by a simple formula, especially in the case of a single regressor on the right-hand side. The OLS estimator is consistent when the regressors are exogenous and there is no perfect multicollinearity, and optimal in the class of linear unbiased estimators when the errors are homoscedastic and serially uncorrelated. Under these conditions, the method of OLS provides minimum-variance mean-unbiased estimation when the errors have finite variances. Under the additional assumption that the errors be normally distributed, OLS is the maximum likelihood estimator. OLS is used in economics (econometrics), political science and electrical engineering (control theory and signal processing), among many areas of application. The Multi-fractional order estimator is an expanded version of OLS (Greene, 2002).

3.2. Model, Data and Variables

The model presented in this research paper inspired by Teixeira and Fortuna (2010) is as follows:

$$LEXPORT = \beta_0 + \beta_1 L(R\&D) + \beta_2 L(HC) + \beta_3 L(TOT) + \varepsilon_i \qquad (1)$$

LEXPORT log Iran's export value in dollar terms, LR&D indicates that the R&D index is expressed by log added value of industry and LTOT is, the log of terms of trade. The study period is 1975 to 2012 for annual data and the type of the data is time series data. The model presented in this study previously presented, is estimated using OLS method and are analysed the relationship between the dependent variable and the independent variables.

4. EMPIRICAL ANALYSIS

4.1. Checking Stationary of Variables

A stationary time series is one whose statistical properties such as mean, variance, autocorrelation, etc. are all constant over time. Most statistical forecasting methods are based on the assumption that the time series can be rendered approximately stationary through the use of mathematical transformations. The predictions for the stationarized series can then be "untransformed," by reversing whatever mathematical transformations were previously used, to obtain predictions for the original series. Thus, finding the sequence of transformations needed to stationarize a time series often provides important clues in the search for an appropriate forecasting model. Another reason for trying to stationarize a time series is to be able to obtain meaningful sample statistics such as means, variances, and correlations with other variables. Such statistics are useful as descriptors of future behaviour only if the series is stationary. For example, if the series is consistently increasing over time, the sample mean and variance will grow with the size of the sample, and they will always underestimate the mean and variance in future periods. And if the mean and variance of a series are not well-defined, then neither are its correlations with other variables. For this reason you should be cautious about trying to extrapolate regression models fitted to non-stationary data. In this study Augmented Dickey-Fuller test is used to check stationary of variables. The results are shown in Table 1.

Table 1. Stationary of variables using Augmented Dickey - Fuller

Variables	ADF statistics	The C V of 10%	The C V of 5%	The C V of 1%	Result
LEXPORT	-2/6852	-3/2003	-3/5366	-4/2268	Non Stationary
DLEXPORT	-3/8961	-3/2046	-3/5442	-4/2442	Stationary
LR&D	-4/3400	-3/2070	-3/5484	-4/2528	Stationary
LHC	-6/4149	-3/2253	-3/5806	-4/3239	Stationary
LTOT	-8/0248	-3/2096	-3/5529	-8/0248	Stationary

Sources: research findings

According to results, All variables are static except export, which is also stationary with once time differencing.

4.2. Estimation of the model by OLS method

In this section model is estimated by OLS method. Table 2 showed the results of the effects of R&D and human capital on export of Iran in the period 1975 to 2012.

Table 2. Results of effects of R&D and human capital on export of Iran by using OLS

Variables	Coefficients	T statistics	Prob
LR&D	0/3319	8/6941	0/0000
LHC	0/5832	5/4201	0/0000
LTOT	0/2824	5/9947	0/0000
R^2 =0/6938	$\overline{R^2}$ =0/6758		D-W =1/79

Sources: research findings

OLS method results show that all coefficients of variables are statistically and theoretically significant. Value added of the industry as an indicator of R&D is estimated to be positive. This shows that with the increase in the value added of industry, exports also increased. Export experience will stimulate firms to invest in technology. It should also be noted to achieve economic development the development of technology in the industrial sector must be

considered, because with the expansion of exports domestic and foreign market grows and then investing in R&D is profitable. As it can be seen with a 1 percent increase in the human development index, exports increase to the 0/58 percent. This indicates that with improved human development index, we can see an increase in exports. Improve efficiency and increase mental and physical health workforce increases the productivity of the labor force. It is worth mentioning greater labor productivity raise the production capabilities and export. The elasticity estimates for changing the terms of trade is also positive. This shows an increase of 1 percent of the terms of trade, exports about 0/28 percent increase. One of the main components of trade is export. With the improvement of the terms of trade and competitive advantage, production of high quality goods will become more and this can be goes up level of exports. R^2 predicted by the model is equal to 0/69. This indicates the explanatory power of the independent variable and shows the high percentage of confidence in the results.

4.3. Diagnostic Tests

The model, performed diagnostic tests. The assumptions of the classical regression model explains the characteristics of the random component and all the results and analysis of the estimation equations are mainly based on this assumption (Tashkini, 2005, Souri, 2012). These tests include Normality of residuals, Check the serial correlation, Conditional Heteroskedasticity and Examination of Ramsey test.

4.3.1. Normality of Residuals

According to the statistical probability-for Jarque-Bera is equivalent to 0/143 from the 5% level higher than the null hypothesis of normality of the accepted residuals. Given the probability distribution of residuals is normal and does not reject the classical assumption.

Figure 1. the Normality of residuals the OLS estimate

Series: Residuals	
Sample 1975 2012	
Observations 37	
Mean	-0.004452
Median	-0.020404
Maximum	0.232780
Minimum	-0.131818
Std. Dev.	0.085899
Skewness	0.787861
Kurtosis	3.189024
Jarque-Bera	3.882886
Probability	0.143497
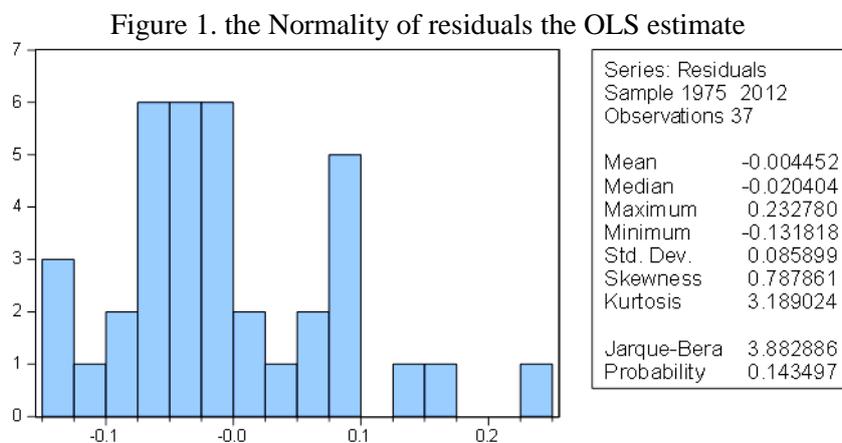
4.3.2. Checking the Serial Correlation

Table 3 shows the results of serial correlation of residuals.

Table 3. The results of serial correlation of residuals

Test	Test statistics	Prob
F-statistic	0/152453	0/8592
Obs*R-squared	0/248057	0/8834

Sources: research findings

As shown in Table 3 you can see the probability of two test statistics Breusch-Godfrey of error of five percent. This implies acceptance of serially uncorrelated residuals H0 is that the evidence is there. So the hypothesis is that one of the classic assumptions were confirmed.

4.3.3. Checking the Conditional Heteroskedasticity

The existence of heteroscedasticity is a major concern in the application of regression analysis, including the analysis of variance, as it can invalidate statistical tests of significance that assume that the modelling errors are uncorrelated and uniform—hence that their variances do not vary with the effects being modelled. For instance, while the ordinary least squares estimator is still unbiased in the presence of heteroscedasticity, it is inefficient because the true variance and covariance are underestimated. Similarly, in testing for differences between sub-populations using a location test, some standard tests assume that variances within groups are equal. Because heteroscedasticity concerns expectations of the second moment of the errors, its presence is referred to as misspecification of the second order (long et al, 1993). Auto-Regressive Conditional Heteroskedasticity test or the same ARCH LM is a test to detect heterogeneity of variance of residuals model. The results of heterogeneity of variance of residuals is showed in table 4.

Table 4. The results of heterogeneity of variance of residuals

Test	Test statistics	Prob
F-statistic	0/380480	0/7677
Obs*R-squared	1/237008	0/7441

Sources: research findings

Table 4 shows the test results Arch. As is observed, the probability of the F statistic is 0/76 which is greater than five percent. So hypothesis H_0 is accepted. After considering the results of variance heterogeneity of variance model residuals is constant. Due to the heterogeneity of variance test result the residuals of the model have constant variance.

4.3.4. Examination Ramsey Test

One of the assumptions of the classical regression equation is that the functional form is correct. But this assumption may not be true and the equation is another. The Ramsey Regression Equation Specification Error Test (RESET) test is a general specification test for the linear regression model. More specifically, it tests whether non-linear combinations of the fitted values help explain the response variable. The intuition behind the test is that if non-linear combinations of the explanatory variables have any power in explaining the response variable, the model is miss-specified (Wooldridge, 2013).

Table 5. The results of Ramsey test

Test	Test statistics	Prob
F-statistic	0/387417	0/5379
Log Likelihood Ratio	0/431846	0/5111

Sources: research findings

Table 5 shows the results of Ramsey test. As can be seen, according to the results, the model is correct specification.

4.3.5. Check the Structural Stability of the estimated model

4.3.5.1. Total Cumulative CUSUM test

Total Cumulative test, carried out, based on the cumulative residuals. In this test, the cumulative graph of residuals at a critical time in the range of lines shown. If the crisis is the cumulative residuals from the area between the lines, shows a lack of structural stability (Shirinbaksh and Khansari, 2009). Figure (2) shows the total cumulative residuals of the test result. As you can see the cumulative sum of residuals in the range of critical lines and out of it yet, so the estimated parameters are stable and there is no model of structural failure.

Figure 2. Results of CUSUM test
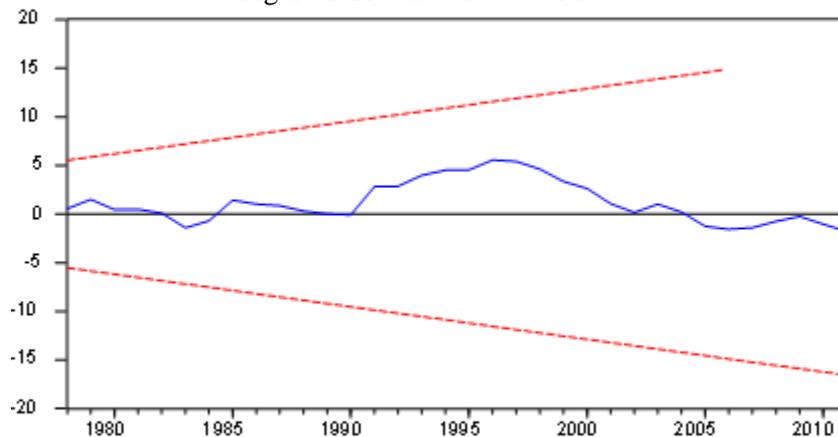
4.3.5.2. Total Cumulative CUSUM of Squares test

Test cumulative sum of squared residuals based on the cumulative sum of squared residuals will be returned. Chart cumulative sum of squared residuals returned it to add two critical line shows.

Figure (3) shows the results of the cumulative sum of squared residuals returned. As you can see from the Figure the cumulative sum of squared residuals within the scope of lines is critical, so the model is estimated to have structural stability and structural failure not happened.

Figure 3. Results of CUSUM of Squares test
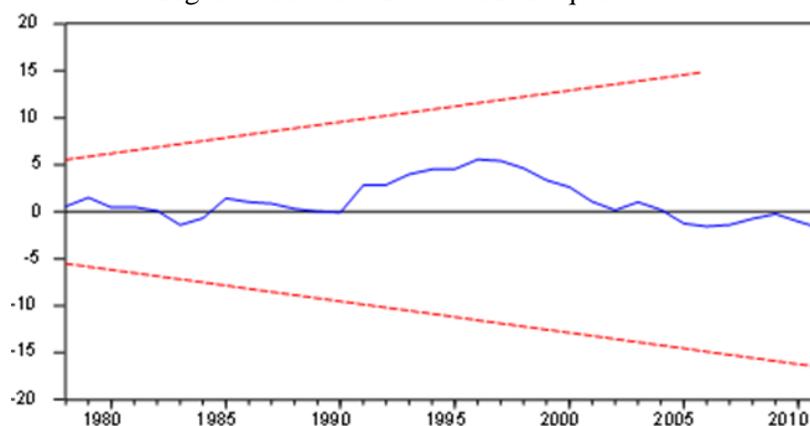
6. CONCLUSION

In economic literature, special attention has been focused on foreign trade as growth factor. Therefore, the strategy of export promotion as a successful strategy, has attracted the attention of many economists. The classical and neoclassical traditional growth theories emphasized the relationship between exports and economic growth and believe that the development of international trade leads to increased productivity efficiency in the allocation of export and finally, will lead to reallocation of resources from inefficient sectors of the commercial and business sectors that these phenomena can contribute to economic growth. In general, the adverse effects of export growth include increased production of factor productivity, efficiency in resource allocation, development of technology and the use of modern technology, providing the possibility of economies of scale and increased specialization of labour. Studies in different countries show that all developing countries face the problem of efficient use of capacity. Export Development can also be useful in various parts of the political and social aspects for governments. Iran is also in development programs, paid special attention to the development of exports. So, government economic planners and policymakers should try to make use of any kind of policy to achieve more exports. Thus, it can be said that the most important is the attention to factors affecting export. Therefore, the present study examined the impact of R&D and human capital on Iran's exports in the period 1975 to 2012 using OLS method. The results showed that R&D and human capital development have positive effects on exports. Also, the terms of trade has a positive effect on exports of Iran.

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ETHICAL CONSIDERATION

Authenticity of the texts, honesty and fidelity has been observed.

AUTHOR CONTRIBUTIONS

Planning and writing of the manuscript was done by the authors.

CONFLICT OF INTEREST

Author/s confirmed no conflict of interest.

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