نشریه علمی

اقتصاد و توسعه کشاورزی

(علوم و صنایع کشاورزی)

جلد ۳۷ شماره ۲

سال ۱۴۰۲

شماره پیاپی ۵۹

شاپا: ۴۷۲۲-۲۰۰۸

عنوان مقالات

نشریه اقتصاد و توسعه کشاورزی

(علوم وصنایع کشاورزی)

با شماره پروانه 21/2015 / 68/4/11 و درجه علمی – پژوهشی شماره 26524 / 73/10/19 از وزارت علوم، تحقیقات و فناوری

جلد 37 شماره2 تابستان 1402

بر اساس مصوبه وزارت عتف از سال 1398، کلیه نشریات دارای درجه "علمی-پژوهشی" به نشریه "علمی" تغییر نام یافتند.

ناشر: دانشگاه فردوسی مشهد

نشانی: مشهد- کد پستی 91775 صندوق پستی 1163

دانشکده کشاورزی _ دبیرخانه نشریات علمی _ نشریه اقتصاد و توسعه کشاورزی

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این نشریه در سایت https://jead.um.ac.ir/ به صورت مقاله کامل نمایه شده است.

این نشریه به صورت فصلنامه (4 شماره در سال) چاپ ومنتشر می شود.

بسم الله الرحمن الرحیم

مندرجات

Journal of Agricultural Economics & Development

Homepage: https://jead.um.ac.ir

Full Research Paper
Vol. 37, No. 2, Summer 2023, p. 119-130

Agricultural Insurance and Sustainable Food Supply Systems: An Assessment for Nigerian Farmers

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Received: 19-09-2022	How to cite this article:
Revised: 01-03-2023	Ajemunigbohun, S.S., & Abdul-Azeez, I.F. (2023). Agricultural insurance
Accepted: 06-06-2023	and sustainable food supply systems: an assessment for Nigerian farmers.
Available Online: 06-06-2023	*Journal of Agricultural Economics & Development*, *37*(2): 119-130.
	https://doi.org/10.22067/jead.2023.78280.1159

Abstract

Agriculture plays a pivotal role in Africa's development and is essential for achieving the Sustainable Development Goals (SDGs). However, the agricultural sector is inherently exposed to production risks, and many farmers in the developing world lack access to reliable agricultural insurance coverage. This situation arises due to limited data and knowledge about farmers' insurance needs and the high costs associated with insuring against severe agricultural risks. Promoting agricultural insurance as an instrument can have several significant impacts, aligning with multiple SDGs. It can help stabilize farmers' income, thereby contributing to the goal of reducing poverty (SDG 1). Moreover, agricultural insurance can provide a safety net for food producers, helping them manage the impacts of climate-related risks and aligning with SDG 13, which addresses climate action. Additionally, by enhancing the resilience of farmers and ensuring more predictable income, agricultural insurance can contribute to addressing hunger (SDG 2) and ultimately create a more sustainable and prosperous agricultural sector in Africa. Therefore, this study evaluated agricultural insurance as an instrument for sustainable food supply systems in Nigeria. This study adopted a survey design. This study captured thoughts, experiences, and observations of selected agricultural underwriters in the Nigerian insurance industry through structured questionnaire. A descriptive statistic was employed in the data analysis. This study results indicated that aside from farmers' awareness which showed some level of yardstick with respect to farmers behavioural metrics, all other metrics played no significant roles. It was also recorded that why farmers' age, gender, family size and farming experience have no significant roles in the uptake of agricultural insurance, all other participatory factors have major effects. The study contributed significantly to knowledge with the graphical representations of the challenges confronting the agricultural insurers in Nigeria. The study provided suitable recommendations that endear achievable SDGs in Nigeria.

Keywords: Agricultural insurance, Agricultural risk, Nigeria, Sustainable food systems

Introduction

Agricultural production had grown and tripled between the years 1960 and 2015, due to the adoption of green revolution technologies coupled with significant expansion in the use of water, land, and other natural resources for agricultural uses. Studies have affirmed the continued and widespread food deficiency and malnutrition as major challenges in many areas of the globe (FAO, 2017; OECD/FAO, 2021; Olajide-Adedamola and Akinbilo, 2018). Oyetunde, Odum, and Adewunmi (2021) stipulated that the developmental stride put forward to eradicate hunger and food deficiency will not be sufficient even by the year 2050 if adequate efforts are not in place. According to Alliance for a Green Revolution in Africa (AGRA) (2018), 70% of the African populace

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DOI: 10.22067/jead.2023.78280.1159

has been said to be involved in agriculture. It is a proven fact, from this submission, that agriculture is the path to prosperity in Africa because no region of the world has developed into a diverse modern economy without first establishing a successful foundation in agriculture. However, Agriculture is critical to the development of Africa and crucial to the achievement of the Sustainable Development Goal, which seeks to eradicate extreme poverty and hunger by 2030. Over 70% of Africa's population depends on agriculture (International Fertilizer Development Centre, 2014).

In Nigeria, the focus had been on diversifying the economy away from oil to agriculture. Towards meeting this goal, various government programmes to support rice farmers, and other categories of farmers had been put in place. This agricultural drive is in tandem with successive government efforts at achieving sustainable food security and self-sufficiency in food production. All of these had been directed at reawakening the past landmark achievement recorded over the years in the agricultural sector which is regarded as the mainstay of the economy. Nigeria is a vast agricultural country endowed with substantial natural resources. According to Oyakhilomen and Zibah (2017), the agricultural sector is said to account for over 40% of the GDP and thus, employs about 60% of the working population. Over 53 million (about 30 per cent) Nigerians remain undernourished, and many Nigerians (65 per cent) remain food insecure (Nwankpa, 2017). Hence, prioritising agriculture and intensifying efforts on agricultural production will serve as a veritable instrument that potentially endears to sustainable capacity in food production and supply (Akpan, Udoka, and Patrick, 2021; Amao, Antwi, Oduniyi, Oni, and Rubhara, 2021).

Given the current economic situation in Nigeria coupled with hyperinflation and hunger in the land, the government is putting more effort into revamping the agricultural sector with the desire to not only boost the sector but restore the lost glory of Nigeria in self-sufficiency in food production and supply. These efforts were geared toward encouraging more people into agricultural (either as an investor or a farmer) to reduce the alarming rate of unemployment and enhance the economic diversification policy of the government. This desire had made it imperative that proven scientific and appropriate economic means for managing the various risks that are associated with agricultural endeavours are brought to the fore.

Therefore, it is important to acknowledge the role of agricultural insurance in realising these government objectives (advancement of agricultural sector, provision of agricultural inputs, etc.) and protecting farmers against possible agricultural risks (such as production risks, environmental risks, logistics and infrastructural risks). Agricultural risk is a central theme in farming globally due to the threats of pests and diseases, bush fires, herders' activities, drought, and price fluctuations. In Nigeria, farmers have been disturbed by the activities of herders, bandits, kidnappers, and political unrest, among others. But a great majority of them, due to insufficient means and resources, are rarely able to withstand the risks, especially when it involves disastrous losses. The result, often, is a serious decline in farm income and the consequent failure (Udemezue and Kanu, 2019). Thus, this underscores the need for this research to assess how agricultural insurance can be used as an instrument for sustainable food supply systems in Nigeria. In specific terms, the objectives are to:

i. Take an overview of agricultural insurance and identify the demand-and supply-sides factors affecting the uptake of agricultural insurance;
ii. Study the existing farmers' behavioural metrics toward agricultural insurance based on the judgment of Agricultural insurance providers;
iii. Assess the possible factors influencing farmers' participations in agricultural insurance in Nigeria;
iv. Examine the various challenges confronting Agricultural insurers in Nigeria

Overview of Agricultural Insurance: Global perspective

Agricultural sector is the most pertinent facet in many countries which is still being impacted by climate shock. Apart from threatening global food security and stability, these shocks can cripple livelihoods, disrupt agricultural value chains, and even subvert macroeconomic stability. Agricultural insurance de-risks lending to the agricultural sector, enabling loan repayments, curtails budget volatility of agriculture-related financial expenditures by ceding climate risk to the private sector, increases financial space during shock years, and estimates growth of the agricultural sector, which can unlock job creation opportunities (Baskaran and Maher, 2021).

Agricultural insurance is an increasingly attractive sector that is experiencing rapid growth. In the year 2019, the agricultural insurance market was valued at over 30 billion U.S. dollars (Wang, Tack, and Coble, 2020; Vyas, Dalhaus, Kropff, Aggarwal, and Meuwissen, 2021). However, climate change, in many regions of the world, has been ascribed an essential driver of agricultural system instability and is anticipated to increase the probability and severity of risks. Therefore, among numerous agricultural risk management instruments available, one major plan of action to manage these risks is agricultural insurance (Vyas *et al*., 2021). Agricultural insurance, according to Siwedza and Shava (2020), can help stabilise farm income by reducing poverty (Sustainable Development Goals. SDG 1), ensuring a climate safety cover for food producers (SDG 13), and creating more welfare packages to address hunger (SDG 2).

Agricultural insurance is a financial instrument which provides coverage for agricultural production assets of all biological systems including crop, forestry, livestock, fishing, and farm properties. Agricultural insurance is one of the alternative risk management methods available for risk management against climatic variations. It serves as the only medium through which production risks in agriculture are ceded from individual producers, agro-enterprises, and government organisations to (re) insurers or other financial markets (Hohl, 2019).

The evidence above shows that insurance product (especially agricultural insurance) in developing countries is grappling with the provision of safety cover for a range of shocks and challenges which are beyond the farmers' control and can impact drastically on their incomes and survival. It can be deduced from the figure above that while 22 percent of farmers are figured to have knowledge of agricultural insurance in Asia, 33 percent in Latin America, only 3 per cent of these farmers, globally, are figured to be aware of agricultural insurance in Sub-Saharan Africa. Studies (such as Panda, 2021; Yonekura, 2019) had proved that agricultural insurance in the Asian region is bolstered primarily by the republic of China, Japan, and India. More so, studies (such as Ntukamazina, Onwonga, Sommer, Rubyogo, Mukankusi, Mburu, and Kariuki, 2017; Osumba, Recha, Demissie, Shilomboleni, Rademy, and Solomon, 2020) had stipulated that agricultural insurance penetration is very low in most African countries by either not having it or experiencing it only at the pilot stage.

Agricultural insurance in Nigeria

The drive for agricultural insurance in Nigeria was said to have started with the establishment of the Nigerian Agricultural Insurance Scheme (NAIS). The essence of its emergence was to provide financial remediation to farmers having suffered natural hazard; stimulate financial institutions, provide rural credit; promote agricultural production by motivating investment; and reducing the need for government to offer support after a disastrous events.to be able to attain these objectives, the Federal Government of Nigeria (FGN) considered it necessary to establish the Nigerian Agricultural Insurance Corporation (NAIC).

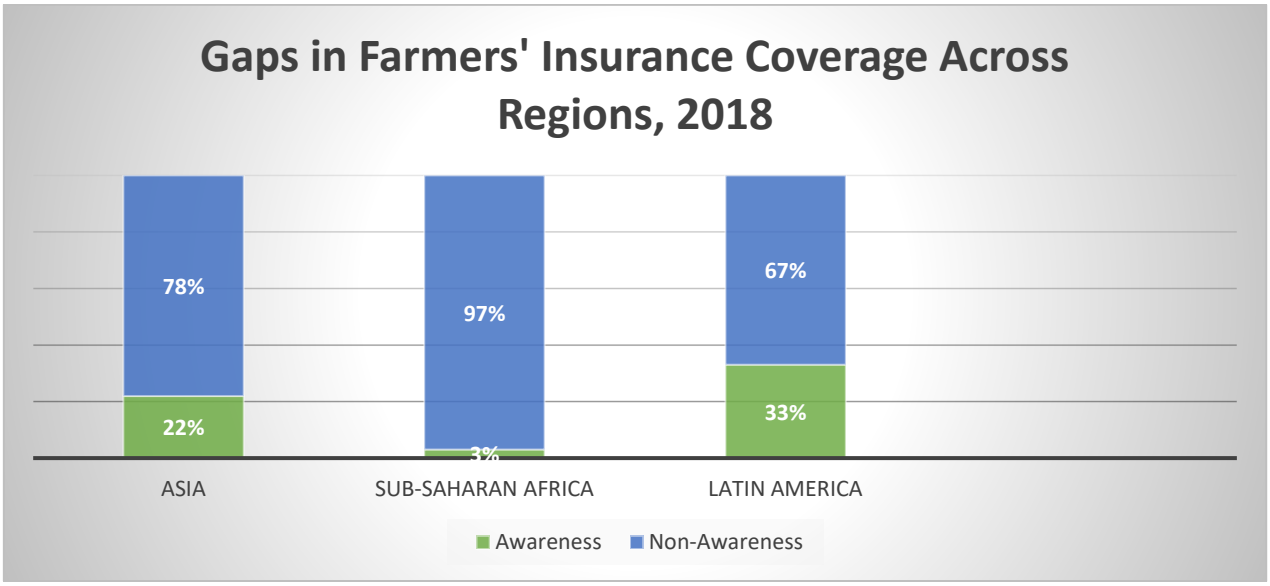

Figure 1- Gaps in farmers' income coverage across region, 2018
Source: ISF Advisors (2018). Protecting growing prosperity

The NAIC (Nigerian Agricultural Insurance Corporation), once established, has taken on the crucial responsibility of protecting Nigerian farmers against the potential impacts of natural hazards. It achieves this by implementing measures that ensure prompt and appropriate compensation, sufficient to help affected farmers recover and continue their agricultural activities despite suffering losses (Olajide-Adedamola and Akinile, 2018). Government continuous participation ensures subsidies' provisions for food crops, cereals, live stocks, poultry, and fisheries without commercialisation. NAIC, being the only corporation that represents government's interest in agricultural insurance, is empowered to perform such responsibilities as stated above (Oyetunde *et al.*, 2021). Currently, the agricultural insurance market is comprised of one (1) government fully funded corporation (NAIC) and eighteen (18) private agricultural underwriters. The products presently being offered in the market include poultry insurance, fish farming insurance, livestock insurance, multicrop peril insurance, crop insurance, and farm properties, and produce insurance.

Demand- and Supply-Side Barriers to the uptake of Agricultural Insurance

Evidence has demonstrated that the insurance coverage gap persists due to a combination of demand-side and supply-side factors. On the demand side, one significant challenge is the lack of awareness about insurance services, primarily driven by the limited access to financial services in rural areas. This lack of access serves as a fundamental barrier to the adoption of insurance. Even in cases where farmers are aware of insurance, insufficient knowledge and understanding of this financial instrument can lead to distrust in service providers' abilities to honor claims as promised.

Additionally, for those farmers who are aware of insurance services, effective utilization of agricultural insurance becomes feasible when they possess a clear understanding of how it works and the value it can provide to them. However, uptake of agricultural insurance among farmers is being constrained by two likely costs, namely cost of insurance premium and claim costs.

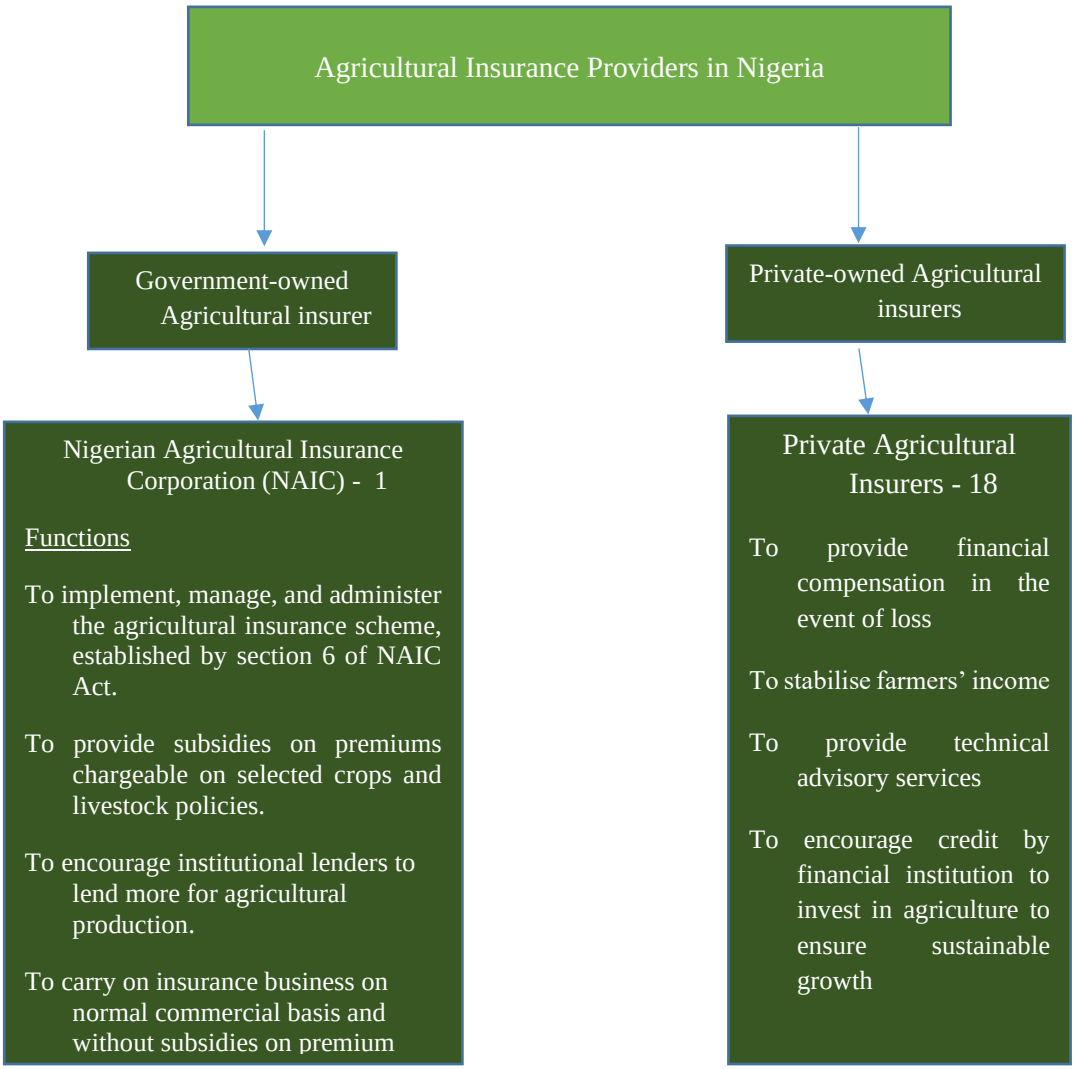

Figure 2- Structure of Agricultural Insurance Market in Nigeria

Source: Researchers' model, 2022

Apparently, government subsidy, as a demand factor, has been employed to reduce premiums for farmers on government-mandated schemes or specific agricultural insurance services. These claims are also supported by recent studies (Ghosh, Gupta, Singh, and Ward, 2021; Nshakira-Rukundo, Kamau, and Baumuller, 2021; Sujarwo, 2017). On the supply-side factors, an agricultural insurance provider encounters high incidence of disastrous events such as drought, flood, etc.., with core requirements of huge and more persistent pay-outs. In addition, providing coverage for such agricultural risks can be expensive for providers who would scuffle to design agricultural insurance policies that are both low-priced and offer ample coverage. Distribution is key challenge, hence reaching and serving farmers can be logistically laborious and high-priced. Given the sensitivity of the price, insurance underwriter most times perceived this policy as a low-profit customer aspect, preventing themselves from offering the policy. However, with no access to formal insurance schemes (especially government support/subsidies), farmers usually resort to traditional risk management, such as self-insurance and community fund. While self-insurance can be expensive and profitless against major weather shocks, community

funding schemes, in which farmers contribute their savings into a pool to support those who require pecuniary assistance, may not usually provide sufficient safety cover (Raithattha and Priebe, 2020; Stoppa and Dick, 2018). The main problem is that traditional risk management schemes are not able to cater for covariate risks, which refer to disastrous situations that affect many farmers in the same region at the same period.

Research Methods

This study, which is empirical, analytical, and descriptive, captures the thoughts of agricultural insurance providers on issues relating to farmers' behavioural metrics, factors influencing farmers' participation in agricultural Insurance, and challenges of agricultural Insurers. This study adopted survey design supported by quantitative method to provide an improved perception of necessary resolutions for agricultural insurance as an instrument to food supply systems in Nigeria. The total population comprised 19 registered and practising agricultural insurance companies in Nigeria (Nigerian Insurance Association, 2020).

The sampling method adopted were purposive and convenience in nature. The data collection instrument selected for this study was a questionnaire, being a primary source method. The choice of the survey method was due to its suitability to the chosen research design, its costless nature, huge sample coverage, and its simplicity in distribution (Sallies, Gripsrud, Olsson, and Silkoset, 2021). Five copies of questionnaires were sent to each provider with each company's unit head inclusive via the researcher's institutional email. To this end, a total of 87 copies were returned, making a 92% response rate.

The study measurement of validity consisted of construct, and face validity. While construct validity was structured in line with convergent and discriminant views of earlier studies, face validity was conducted among experts in agricultural insurance to be able to come up with useful research instrument for the data collection. Also, the reliability test was conducted with a Cronbach alpha above the standard 0.7 for all constructs of concern. These outcomes were in line with statistical inferences of the validity of the scale, and the sacrosanctity of the internal consistency.

Results and Discussion

Fig. 3 shows farmers' behavioural metrics in terms of their awareness, patronage, attitudes, preferences, and experiences. For the statement that "farmers' awareness has contributed greatly to agricultural insurance policies in Nigeria", while 45.5 percent disagreed with it, 4.5 percent undecided, 22.7 percent expressed their agreement, and 27.3 percent were strongly in agreement with the statement. This implies that while 50 percent agreed with the statement, 45.5 percent disagreed. For the statement that "farmers' patronage for agricultural insurance in Nigeria is high", while 9.1 percent only expressed strong disagreement, 27.3 percent were undecided, and 63.6 percent indicated their agreement. This implies that while only 9.1 percent expressed their indecision, 90.9 percent were in disagreement with the statement. For the statement that "farmers have positive attitudes to purchasing agricultural insurance", while 9.1 percent signify their strong disagreement, 68.6 disagreed, 9.1 percent undecided, and 13.6 percent displayed their agreement. It shows that more than 70 percent disagreed with the statement. For the statement that "farmers' preferences for agricultural insurance policies had been huge", while 77.3 percent disagreed with the statement, 9.1 percent expressed their indecision, and 13.6 percent displayed their agreement.

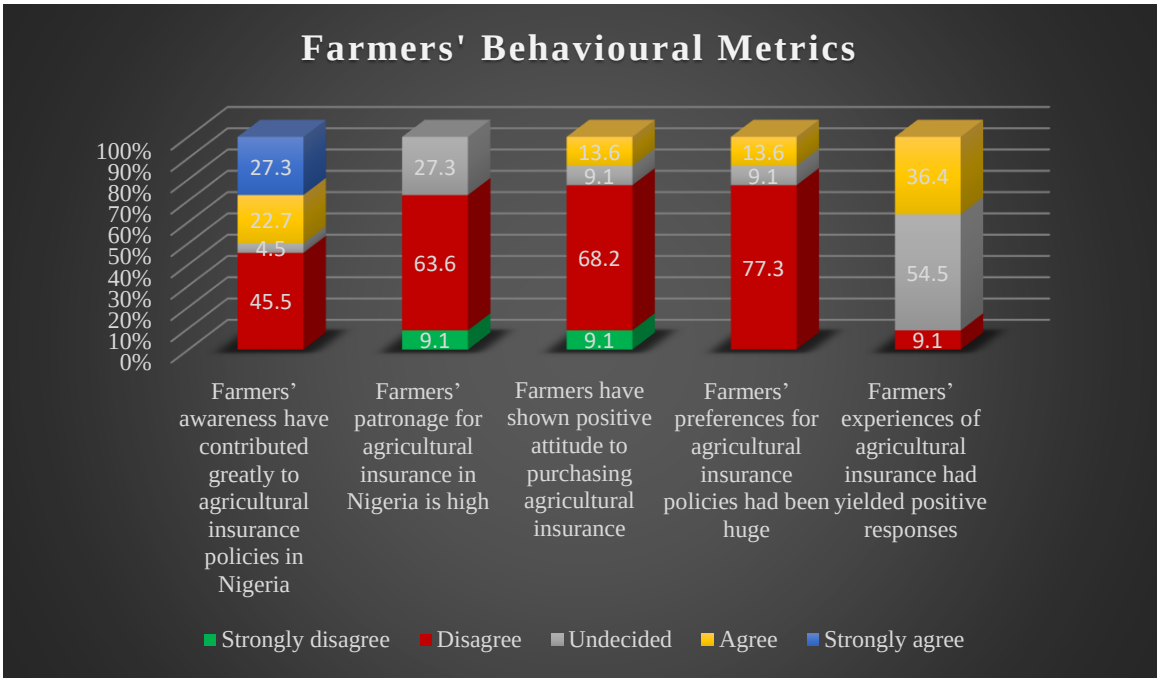

Figure 3- The graphical model explains Farmers' behavioural metrics for agricultural insurance
Source: Field Survey, 2022

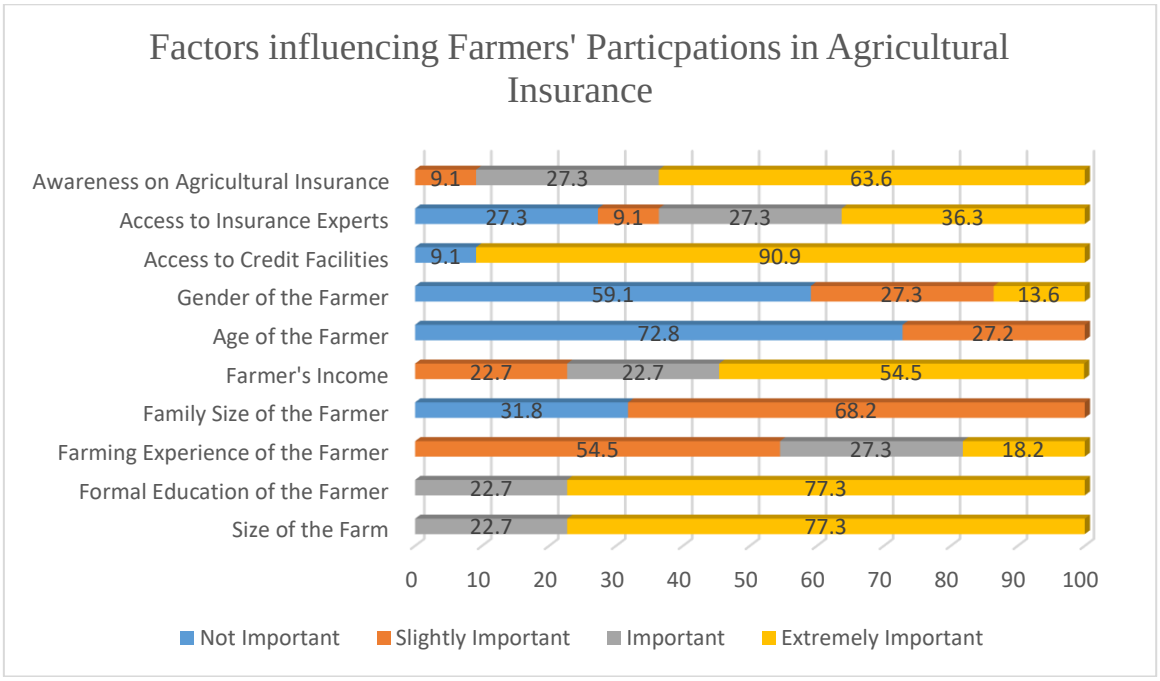

Figure 4- The graphical model explains factors influencing farmers' participations in agricultural insurance in Nigeria
Source: Field Survey, 2022

It also implied that over 70 percent disagreed with the statement. For the statement that "farmers' experiences of agricultural insurance had yielded positive responses", while 54.5 percent expressed their indecision, 36.4 percent agreed, and 9.1 percent disagreed. The reason

for the results is that while farmers desire towards agricultural insurance, on the judgment of the agricultural underwriters, have been negatively affected in terms of their patronage, attitudes, experiences, and preferences; more positive outcomes are recorded with respect to their level of awareness.

Fig. 4 shows the participants' responses regarding factors influencing farmers' participations in agricultural insurance. For size of the farm, while 77.3 percent of participants see it as extremely important, 22.7 percent attached some level of importance. For 'farmer's formal education', 77.3 percent account for extremely important and 22.7 percent important. For 'farmer's farming experience', while 54.5 percent of the entire agricultural underwriters see it as slightly important, 27.3 and 18.2 percent account for some level of importance and extreme importance respectively. For 'family size of the farmer', while 68.2 percent of the entire participants see it as slightly important, 31.8 percent attached no importance. For 'farmer's income', while 54.5 percent of the entire participants see it as extremely important, 22.7 percent account each for both its importance and slight importance. For 'age of the farmer', while 72.8 percent of the entire participants see it as not important, 27.2 percent attached slight importance. For 'gender of the farmer', 59.1 percent of the entire participants see it as not important. While 27.3 percent account for its slight importance, 13.6 percent saw it as extremely important. For 'access to credit facilities', 90.9 percent of the entire participants see it as extremely important, while 9.1 percent account for its importance. For 'access to insurance expert', 36.3 percent of the entire participants see it as extremely important. While 27.3 percent each account for both not important and important, only 9.1 percent account for its slight importance. For 'awareness on agricultural insurance', 63.6 percent of the entire participants see it as extremely important. While 27.3 percent account for its importance, just 4.1 percent attached slight importance.

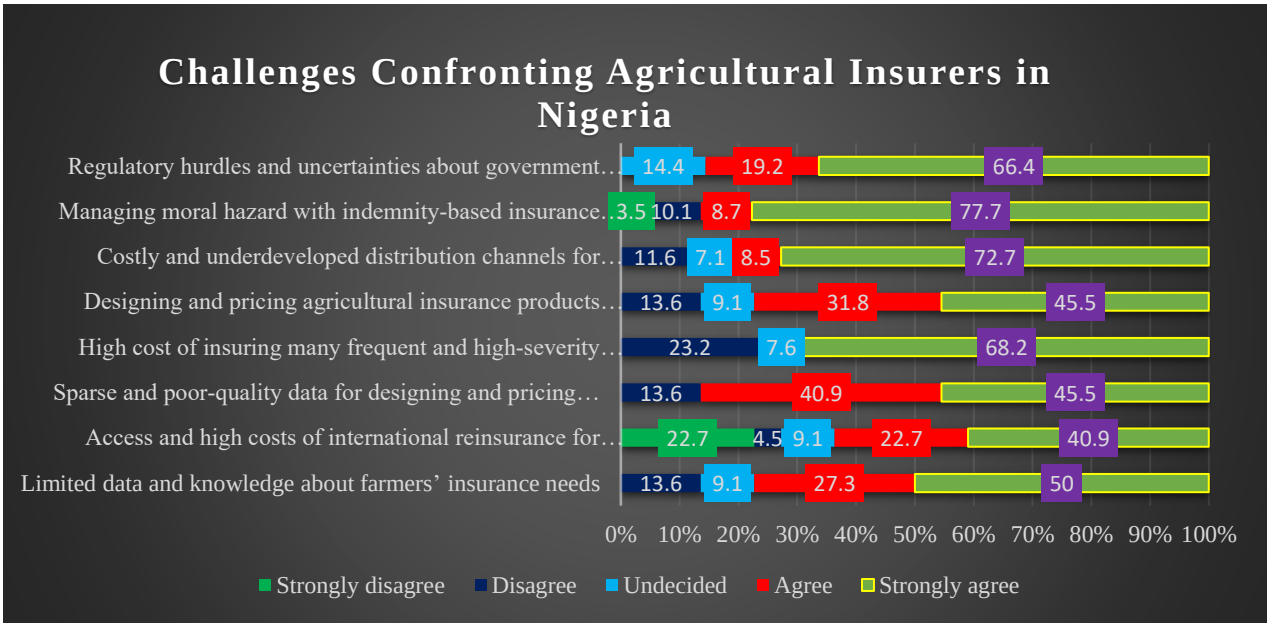

Figure 5- The graphical model explains challenges confronting agricultural insurers in Nigeria
Source: Field Survey, 2022

The adopted factors were in consistent with studies (such as Ajiboye, Adeyonu, Faseyi, and Isitor, 2018; Ankrah, Kwapong, Eghan, Adarkwah, and Boateng-Gyambiby, 2021; Carrer, Franco de Silveira, Vilholis, and De Souza Filho, 2019) regarding agricultural insurance.

Fig. 5 shows the participants' responses

about challenges encountered with providing agricultural insurance products in Nigeria. For Limited data and knowledge about farmers' insurance needs**,** while 50 percent of participants strongly agreed to the statement, 27.3 percent expressed their agreement, 13.6 percent disagreed and 9.1 percent were undecided. For 'access and high cost of international reinsurance for agricultural insurance' 40.9 percent account for strong agreement and 22.7 percent agreed. While 22.7 percent strongly disagreed expressed their strong disagreement, 9.1 percent undecided, and 4.5 percent of the participants all disagreed. For **'**sparse and poor-quality data for designing and pricing agricultural insurance', 45.5 percent of the entire participants expressed strong agreement, 40.9 percent showcased their agreement, while only 13.6 percent that showcased their disagreement. For 'high cost of insuring many frequent and high-severity agricultural risks', 68.2 percent of the entire participants agreed strongly with the statement. While 23.2 percent disagreed, 7.6 were indecisive. For designing and pricing agricultural insurance products given the uncertainties of climate change', 45.5 percent of the entire participants strongly agreed, 31.8 percent account for those that expressed their agreement. While 9.1 percent were indecisive, 13.6 percent were in disagreement with statement. For 'costly and undeveloped distribution channels for providing agricultural insurance on a large scale to small, disperse farmers', while 72.7 percent of the entire participants agreed strongly with the statement, 8.5 percent expressed their agreement, 11.6 percent disagreed, 7.1 were indecisive. For 'managing moral hazard with indemnity-based insurance and basis risk with index-based insurance for agricultural risks', while 77.7 percent showcased their strong acceptance, 8.7 expressed their agreement, 10.1 percent account for its disagreement, and 3.5 percent disagreed strongly. For 'regulatory hurdles and uncertainties about government policies that may affect the financial viability of private agricultural underwriters', while 66.4 percent of the entire participants indicated their strong agreement, 19.2 ordinarily agreed, and 14.4 percent account for its indecision. These challenges are in consistent with studies (such as Ehiogu and Chidiebere-Mark, 2019; Elum and Simonyan, 2016) concerning agricultural insurance.

Conclusion

The study focused on agricultural insurance as an instrument for food supply systems in Nigeria. Without doubt, agricultural risks (such as pests, diseases, droughts, fire, climate change, etc.) present serious challenges to the survival of individual farmers, income and economic of scale in developing countries. This study therefore described the behavioural metrics of farmers based on the judgment of agricultural underwriters, study existing factors influencing farmers' participations in agricultural insurance, and scrutinise the current challenges being faced by agricultural underwriters in Nigeria.

The study recommended that private agricultural underwriters should do more on its enlightenment to the farmers and also, design agricultural insurance products tailored towards agrarian farming needs at a given time. The National Insurance Commission should develop sustainable regulatory framework that can fascinate the agrarians in the Nigeria to purchase agricultural insurance policy, as both social and financial instrument. Conclusively, NAIC, as a government-owned agricultural insurance organisation, should provide more subsidies for farmers to motivate their patronage, positive attitude, preferences, and experiences.

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Journal of Agricultural Economics & Development

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مقاله پژوهشی

جلد ۳۷ شماره ۲، تابستان ۱۴۰۲، ص. ۱۳۰-۱۱۹

بیمه کشاورزی و نظام‌های تامین غذای پایدار: ارزیابی کشاورزان نیجریایی

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تاریخ دریافت: ۱۴۰۱/۰۶/۲۸

تاریخ بازنگری: ۱۴۰۱/۱۲/۱۰

تاریخ پذیرش: ۱۴۰۲/۰۳/۱۶

چکیده

بخش کشاورزی نقش مهمی در توسعه قاره آفریقا و دستیابی به اهداف توسعه پایدار (SDGs) دارد. با این حال، ریسک تولید در بخش کشاورزی فراگیر است، و همچنان، کشاورزان در سراسر کشورهای در حال توسعه، به دلیل محدودیت داده و دانش در مورد نیازهای بیمه‌ای کشاورزان و هزینه‌های گزاف بیمه برای پوشش ریسک‌های کشاورزی، به پوشش بیمه کشاورزی با کیفیت دسترسی ندارند. برای این منظور، بهبود بیمه کشاورزی، به عنوان یک ابزار، می‌تواند به ثبات درآمد کشاورزی و در نتیجه کاهش فقر، به عنوان هدف اول توسعه پایدار (SDG 1)، اطمینان از محیط مناسب برای تولید غذا (SDG 13)، و ایجاد یک بسته (حمایتی) با رفاه بیش‌تر برای رفع گرسنگی (SDG 2) کمک کند. بنابراین، این مطالعه به ارزیابی بیمه کشاورزی به عنوان یک ابزار برای نظام‌های تولید غذای پایدار در نیجریه می‌پردازد. این مطالعه یک نظرسنجی را در بر می‌گیرد و طی آن طرز نگرش، تجربه و مشاهدات پذیره‌نویسان منتخب کشاورزی در صنعت بیمه نیجریه را از طریق پرسشنامه ساختارمند گردآوری کرده است. برای این مطالعه از آمار توصیفی برای تحلیل داده‌ها استفاده شده است. نتایج مطالعه نشان داد که به غیر از آگاهی کشاورزان، که سطحی از معیارهای مرتبط با رفتار کشاورزان را نشان می‌دهد، سایر معیارها نقش مهمی نداشتند. این نتایج همچنین نشان داد که چرا سن، جنسیت، اندازه خانوار و تجربه کشاورزی نقش معناداری در دریافت بیمه کشاورزی نداشت. برای باقی مولفه‌های مشارکت کننده در این پژوهش تاثیر محوری دانسته شد. این مطالعه به ایجاد یک تصویر از چالش‌های پیش‌روی بیمه کشاورزی در نیجریه کمک کرد. نتایج این مطالعه می‌تواند در ارائه پیشنهادات مناسب برای دستیابی به اهداف توسعه پایدار (SDGs) در نیجریه کمک کند.

واژه‌های کلیدی: بیمه کشاورزی، ریسک کشاورزی، نظام‌های پایدار غذا، نیجریه

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DOI: 10.22067/jead.2023.78280.1159

Journal of Agricultural Economics & Development

Homepage: https://jead.um.ac.ir

Full Research Paper
Vol. 37, No. 2, Summer 2023, p. 131-143

Feedback Trading in Saffron Exchange Traded Funds

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Received: 14-12-2022
Revised: 01-07-2023
Accepted: 19-07-2023
Available Online: 12-08-2023

How to cite this article:
Shaerattar, M., & Mirzapour Babajan, A. (2023). Feedback trading in saffron exchange traded funds. *Journal of Agricultural Economics & Development*, *37*(2), 131-143. https://doi.org/10.22067/jead.2023.80030.1171

Abstract

Commodity Exchange Traded Funds (ETF) are one type of ETF that underlying assets are agricultural products, energy or metals instead of stocks. These ETFs expose their investors to the market of various commodities in different ways, such as physical commodity, futures of single commodity, futures of baskets commodities, equities with exposures to commodities in various forms. In recent years, this financial instrument has become one of the important investment options among several people by creating many advantages. Despite these developments, scarce evidence exists in the current literature on the feedback trading of ETF investors. The objective of this paper is examination of feedback trading in behavior investors of Saffron ETF in Iran. For this purpose, daily data of two Saffron ETF for January 3, 2021 - Novenber 11, 2022 and Sentana and Wadhwani (1992) model was used. Empirical analysis suggests that volatility of fund return is symmetrical against the news. Despite a formal market with full overlapping for the underlying assets, Saffron ETFs investors do not notice about the difference between ETFs' market prices and their Net Asset Value (NAV). The results of the feedback trading model show that there is no evidence of feedback trading in Saffron ETF. It seems that the market of Saffron ETF is efficient, which can be related to the specificity of the underlying assets and the investors of these ETFs.

Keywords: Exchange traded fund, Feedback trading, Saffron commodity ETF

Introduction

Today, passive investment in two forms of open-ended index funds and exchange-traded funds has become an important part of the investment perspective in financial markets. ETFs are shorter-lived than index funds and were first introduced in the U.S. in January 1993 (Kallinterakis *et al.*, 2020). Demand for ETFs has grown markedly, making ETF trading one of the world's largest businesses with an estimated Net Asset Value (NAV) of US$10 billion and an annual growth rate of around 6% (WFE, 2022). ETFs have properties similar to that of mutual funds, and have an added feature of being listed and traded in the stock exchanges like shares (Mallika and Sulphey, 2018). ETFs set forth the diversification opportunities they provide to all types of investors at a lower transaction costs, but also highlight their tax efficiency, transparency and low management fees. All of these features rely on a specific in-kind creation and redemption principle. New shares can continuously be created by depositing a portfolio of stocks that closely approximates the holdings of the fund and similarly, investors can redeem outstanding ETF shares and receive the basket portfolio in return (Deville, 2008).

In recent years, this financial instrument has become one of the important investment options among traders by creating many

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DOI: 10.22067/jead.2023.80030.1171

advantages. Currently, various types of ETFs are traded around the world, So that by the end of the second quarter of 2022, the total number of ETFs in the world is 7,738 with a NAV of just over 8,522 billion $ (IIFA, 2022). Despite the when of ETFs in the world, this asset is divided into two general classes. The first class are divided based on the management structure and the second class based on the underlying assets (Deville, 2008). The first ETF was launched in August 2013 in Iran and after that, the process of entering these ETFs into the Tehran Stock Exchange (TSE) continued. At the moment, 109 ETFs are traded in TSE and total NAV of this ETFs has been at around 8 billion $ on November 2022 (Financial Information Processing of Iran (fipiran), 2022).

Commodity ETF are one of the types of ETF that underlying assets are agricultural products, energy or metals instead of stocks. These ETFs expose their investors to the market of various commodities in different ways, such as physical commodity, futures of single commodity, futures of baskets commodities, equities with exposures to commodities in various forms (Abner, 2016). The advantage of these ETFs is that, in addition to tracking the price of the underlying asset, it makes it possible to invest in a specific commodity, for any person and any amount of assets. At the moment, 9 commodity ETFs are traded in TSE and total NAV of this ETFs has been at around 2 billion $. This commodity ETFs are in two groups of agricultural products and precious metals, traded with two underlying assets, saffron and gold. The number and NAV of these ETFs are about 8% compared to Iran's ETF market. Despite various metal and agricultural commodities in Iran, the existence of these figures shows the low growth and acceptance of commodity ETFs in TSE, which requires further paper and investigation in the field of existing obstacles and problems and their resolution. Given the significance of these instruments, there has been a surging academic interest in the area with an increasing number of studies investigating various topics relating to ETF markets. Despite these developments, scarce evidence exists in the current literature on the trading and investment behavior (rational or irrational) of ETF investors. Intuitively, because of their ease and low cost of trading, ETFs may be appealing to individual (unsophisticated, uninformed) investors who are more likely to chase trends, raising a concern over the impact of their introduction on the overall market efficiency (Kallinterakis and Kaur, 2010). Evidence on the behavior of ETF traders has indicated that they subscribe to feedback style strategies. In an efficient market, free of arbitrage opportunities, the ETF value traded in the market must be equal to its NAV after adjusting for transaction costs (Da Costa *et al.*, 2019). The existence of arbitrators and a liquid market of shares and assets should result in small and temporary price differences between the share and its assets. However, in the context of ETFs, Chau *et al.* (2011) extended Sentana and Wadhwani (1992) model of feedback trading in an empirical analysis of the three largest ETFs in the U.S and found evidence of positive feedback trading, i.e., the existence of traders whose demand is based on the history of previous returns. However, these observations were made from data obtained in the already matured U.S market.

The purpose of this study is to investigate this issue, i.e., the existence of feedback trading in two saffron commodity ETFs in the Iran Mercantile Exchange (IME). Investing in these funds makes it possible for investors to buy and sell fund units immediately, in addition to supporting Iranian farmers and earning profit. Another notable feature of these funds is that they enable even new investors to participate in agricultural product markets without directly trading physical goods in traditional markets and assuming the associated risks. Instead, investors can buy and sell agricultural products in the form of commodity-based investment funds, which provides a more accessible and convenient avenue for investment. Feedback trading is a broad term in finance that describes the behavior of a specific type of trader whose investment decisions are influenced by historical price movements. This is played out by traders abandoning their own information and following that of the crowd−buying (or

selling) concurrently, as a result investors follow the same signal. The practice of feedback trading is founded upon the belief that previous price sequences accommodate discernible and recurrent patterns, which, if successfully identified, can be profitably exploited by assisting investors in predicting future price trends. The remainder of the paper is organized as follows. Section 2 briefly reviews the related literature and previous studies whit feedback trading. Section 3 describes the materials and methods. Section 4 presents and discusses the main experimental results and robustness checks. Finally, Section 5 presents the discussion and conclusions.

Literature review

Feedback trading arises when investors extrapolate previous price patterns. Positive feedback trading entails trading in the direction of the previous patterns−buying when prices rise or selling when prices fall. Negative feedback trading, in contrast, which is also referred to as a contrarian strategy, involves trading in the opposite direction of the previous price patterns − buying when prices fall or selling when prices rise (Kallinterakis and Leite Ferreira, 2007). For example, when the return of an asset is positive (negative) in the previous period, traders will buy (sell) that asset in the next period only considering the positive (negative) return of the previous period. The premise of both these strategies is that the prices maintain some sort of inertia as directional trends tend to persist over long periods of time (Farmer and Joshi, 2002). Positive feedback trading is considered particularly destabilizing as it drives prices away from their intrinsic values and contributes to substantial volatility. In contrast, negative feedback trading is largely viewed as stabilizing as it should bring asset prices back to their intrinsic value (Sentana and Wadhwani, 1992). The notion that leveraging past price patterns can be a lucrative trading strategy contradicts the efficient market hypothesis (EMH). The EMH posits that all available information, including historical price data, should already be incorporated into the current share price. Therefore, according to EMH, it is challenging to consistently profit from exploiting historical price patterns, as the market should have already adjusted for them. The EMH rests on the assumption that most investors are rational and as such, any irrational behavior which drives the price away from its intrinsic value will be arbitraged away rapidly by rational investors. Feedback trading may thus arise because of the irrational behavior of many investors. However, the possibility has also been expounded in the literature that feedback trading may be consistent with rational behavior (Charteris and Musadziruma, 2017). Investors have been found to be susceptible to certain behavioral biases meaning that they may fail to correctly interpret the market signals that they receive. Feedback trading can arise through the joint presence of the two factor: representativeness heuristic and the conservatism bias. The former occurs when an individual draws a conclusion about the general population by overweighting a sample of recent observations and consider it as representative for its properties, while the latter refers to the lagged response of investors to new evidence (Barberis *et al.*, 1998). Overconfidence, which incorporates the self-attribution and hindsight biases, has also been linked with positive feedback trading. For example, if an investor adopts a trading pattern, and certain events subsequently validate the effectiveness of that pattern, the investor might understandably feel a sense of pride. This is known as the self-attribution bias. Furthermore, if the price continues to follow the same trajectory, the investor may come to believe that they accurately predicted this pattern, assuming that others are now also following suit. This phenomenon is referred to as the hindsight bias. These biases can lead to more aggressive trading, which can reinforce existing positive feedback trading tendencies (Odean, 1999). While less common, negative feedback trading has also been linked with behavioral biases. For example, the disposition effect, which refers to the tendency of investors to hold on to shares that have not performed well for too long and sell shares that have performed well too quickly, leads to a reversal of the price trend

(Shefrin and Statman, 1985). Feedback trading can also stem from rational speculation based on expectations of price movements caused by feedback traders. Rational speculators, with an informational advantage, may try to exploit the trading patterns of the feedback traders and their susceptibility to behavioral biases. They do this by initiating a trend based on the available information before it becomes public and then maintain the trend by trying to exploit it. Effectively the rational speculators try to lure feedback traders to chase a trend by mirroring their behavior, to push prices up (or down), ride the bubble and then sell (or buy) the share just before its fundamentals are made available to the rest of the market. In so doing, rational investors will contribute to driving the price further away from its intrinsic value (De Long *et al*, 1990). Rational speculators who choose to use their informational advantage to profit from mispricing, without having instigated the trend in the first place, may also give rise to feedback trading. There are rational traders who trade on share fundamentals and are thus able to estimate any deviation of a share price from its intrinsic value. In such cases, these traders may decide to take advantage of this informational advantage by utilizing threshold-based trading rules to enter or exit the market. These thresholds enable the traders to exploit the mispricing up to the point where it is profitable for them to do so. This is often associated with the employment of stop-loss orders and portfolio insurance strategies and can be justified on the grounds of minimizing transactional costs (Farmer and Joshi, 2002). These strategies lead to sell decisions during market declines thus directly leading to feedback trading (Antoniou *et al*., 2005). That a portfolio insurance strategy can be entirely rational if an investor is risk averse. In such a case, a reduction in the price of a risky asset, caused by an exogenous factor, can lead to a larger reduction in the demand for that share (Sentana and Wadhwani, 1992).

Feedback trading is often considered a specific instance of herding behavior. Herding involves individuals aligning their actions with those of others. In the stock market context, this manifests as traders disregarding their own information and instead following the crowd, leading to simultaneous buying or selling actions. Consequently, investors tend to follow the same trading signals, contributing to herding behavior in the market. In the case of positive feedback trading, that signal is the lagged previous return. The two concepts, however, may be manifested simultaneously. That is, if investors engage in positive feedback trading, then a trend may be amplified if other investors choose to imitate their peers and herd on that trend. Conversely, if herding dominates then this will give rise to a trend in the market and those who wish to join the herd will be engaging in positive feedback trading (Kallinterakis and Leita Ferreira, 2007). The law of one price and the no-arbitrage argument suggest that the price of a basket of securities, such as an ETF, should be equal to the sum of its components' prices (Defusco *et al*., 2011). The price of an ETF in the market is determined based on supply and demand, known as the ETF market price. This price is not necessarily equal to the NAV of an ETF, and according to the market conditions, perspective of traders and value of underlying asset, it can be traded more or less than NAV. Establishing these conditions lead to the creation of price deviation and miss pricing, which provides the opportunity for arbitrage motive to rational speculators (Cherry, 2004). Several studies have been conducted regarding the price deviation and miss pricing of ETFs. For example, can be mentioned the study of Engel and Sarkar (2006), Devvil (2008), Johnson (2009), Ivanov (2013), Charteris *et al*. (2014), Purohit and Malhotra (2015), Dorfleitner *et al*. (2016) and Mallika and Sulphey (2018). In each of the mentioned studies, various factors related to the miss pricing have been mentioned, this has been fundamentally attributed to the non-synchronicity in trading between these ETFs and their underlying assets. According to Kallinterakis *et al*. (2020), the main factor in creating feedback trading in ETF is price deviation between the ETF and NAV. The existence of constant price deviation in ETFs leads to arbitrage opportunity, which requires

the simultaneous trading between the ETF market and the underlying asset. This issue cannot be applied to international ETFs whose trading market is outside the domestic borders, which do not have much overlap in trading hours. Wagner *et al*. (2022) studied feedback trading on US mutual fund in period (1995-2019). Results showed that return seasonality is due to unanticipated fund flow driven by uninformed (flow-motivated) retail investor trading. Active funds indicate flow-induced price pressure with a corresponding reversal of the effect, while passive funds suggest feedback trading instead. Karaa *et al*. (2021) studied feedback trading in Bitcoin using data from the period (2013-2019). Results demonstrated that feedback trading in the Bitcoin grows stronger at higher frequencies, for periods of higher sentiment and volume, and during hours corresponding to the trading hours of major Western stock exchanges. Charteris and Kallinterakis (2021) analyzed feedback trading in gold bullion coin market on South Africa for the March 1996 – August 2019 period. Positive feedback trading is present for the full sample period, before and during the crisis, interacting significantly with a variety of factors related to Krugerrand's pricing, yet dissipates post crisis, likely due to enhanced foreign demand that catapulted the coin's value, rendering it less easy to trade for South African retail investors. Kallinterakis *et al*. (2020) investigates whether feedback traders are active in US-listed country ETFs? Using a sample of nineteen country ETFs for the 2000-2019 window, they find that there are feedback trades in many of them, especially those targeting Asia-Pacific markets. A notable trading point is the broad feedback reported in the vast majority of country ETFs on days when there are successful premium/discount predictions, the fact that the country ETF premium/discount contains Useful information based on their trading dynamics. Chen and McMillan (2020) investigated the relationship between illiquidity, feedback trading and stock returns for several European markets using data (2006-2017) during the financial crisis and sovereign debt. The study results suggest that when price changes are more observable, due to low liquidity, then feedback trading increases. Therefore, during the crisis periods that afflicted European markets, the lower levels of liquidity prevalent led to an increase in feedback trading. Thus, negative liquidity shocks that led to a fall in stock prices were exacerbated by feedback trading. Da Costa *et al*. (2019) presented the results of a study on investor behavior in ETF markets using data for (2003-2012) in a sample of fifteen ETFs contracts in Brazil, South Africa, Korea, Mexico and India, as well as three ETFs contracts in the U.S. market. Their empirical analysis suggests that there is evidence of feedback trading in emerging markets such as Brazil, South Korea, Mexico and India, while there is no such evidence for the U.S. market. The results are consistent with the view that developed markets investors are prone to pursue fundamental driven investment strategies, while emerging markets investors appear to have informational guided behavior. Kyrkilis *et al*. (2018) studied feedback trading for three size-based stock portfolios of Athens Stock Exchange along with the short-term return dynamics during the Greek debt crisis period. Results showed positive feedback trading is an important component of the short-term return movements across the three stock portfolios receives significant support. Moreover, the volatility interdependence, both in magnitude and sign, is almost similar across the three models. Finally, bad news originating from the portfolio of small stock appears to have a higher impact on the volatility of large and medium size stock returns than good news during the Greek debt crisis period. Kuttu and Bokpin (2017) examined feedback trading in the markets of Ghana, Kenya, Nigeria and South Africa using weekly data for (1996-2015) window. They identified positive feedback trading on the South African market, with this trading more pervasive during market declines, with negative feedback trading dominant on the other markets. However, they attributed the finding of negative feedback trading to non-synchronous data rather than the reflection of contrarian traders in the markets.

By reviewing previous studies, specified that

feedback trading in financial markets is great importance as one of the behavior patterns of traders. Using the Sentana and Wadhwani (1992) model and a data set of Iran Saffron ETFs from January 2021 to November 2022, this paper attempts to address the by estimating the feedback trading behavior of Saffron ETF investors.

Materials and Methods

Feedback trading will be evidenced by autocorrelation in asset returns meaning that there is time dependency in returns – the return in the current period will be correlated with the previous period return. However feedback strategies are not commonly used by all investors, because the impact of feedback trading will be more complex than simple time dependency in the first moment of the series. The level of asset return, which indicates autocorrelation, is influenced by the return fluctuations, which indicates the level of risk in the market. An increase in volatility will give rise to an increase in the demand for assets by feedback traders and as such, feedback traders will have a greater effect on the share price, resulting in stronger autocorrelation in returns. In contrast, when volatility is low, the demand for shares by feedback traders will be low leading to lower autocorrelation. Secondly, the sign of autocorrelation depends on the type of feedback traders in the market, with positive feedback trading leading to negative serial correlation in returns while the opposite is true for negative feedback trading (Sentana and Wadhwani, 1992).

Sentana and Wadhwani (1992) model assumes the interaction of two groups of traders in the market. The first group consists of smart money investors, who maximize their expected utility, and second group comprises of feedback traders, who trade on the premises of previous return of ETF. Smart money investors rely on ETF principles and foundations and their behavior is characterized by risk aversion. The demand for ETF by the first group (smart money) investors in period t, is consistent with the maximization of expected mean-variance utility and can be given as follows:

$$Q_{1,t} = \frac{E_{t-1}(r_t - \alpha)}{\theta \delta_t^2} \quad (1)$$

In Eq. (1), where $Q_{1,t}$ is represents the fraction of stocks demanded by these investors, r_t ETF return in period t, E_{t-1} is the expectation in period t − 1 of the ETF's return r_t, in period t, α is the risk-free return, θ is the time-invariant coefficient of risk-aversion and δ^2 is the conditional variance (proxying for risk) at period t. The demand for ETF by the feedback traders is conditioned on the previous period's return as shown by:

$$Q_{2,t} = \gamma r_{t-1} \quad (2)$$

where $Q_{2,t}$ is the fraction of ETF demanded by these traders. As Eq. (2) suggests, feedback traders base their trades on the previous period's return, with the direction of their trades varying, depending on whether they positive. In addition, the coefficient γ may be the sum of positive and negative feedback. For the market to be in equilibrium, all ETFs must be held, in which case, that's mean $Q_{2,t} + Q_{1,t} = 1$ and combining this with Eqs. (1) and (2) yields the equilibrium condition:

$$E_{t-1} r_t = \alpha - \gamma r_{t-1} \theta \delta_t^2 + \theta \delta_t^2 \quad (3)$$

In Eq. (3), term $-\gamma r_{t-1} \theta \delta_t^2$ shown while its signal will depend on the signal of the feedback trading term γ, wherein positive feedback trading will have a negative autocorrelation, and vice versa. Assuming $r_t = E_{t-1} r_t + \varepsilon_t$, substituting (1) and (2) into (3) and rearranging gives:

$$r_t = \alpha - \gamma r_{t-1} \theta \delta_t^2 + \theta \delta_t^2 + \varepsilon_t \quad (4)$$

However, autocorrelation can be the result of both inefficiencies in the market (such as, for example, thin trading) as well as feedback traders and Eq. (4) does not allow us to disentangle between the two possibilities. To that end, Sentana and Wadhwani (1992) suggested the following ad hoc empirical specification of Eq. (5):

$$r_t = \alpha + \theta \delta_t^2 + (\emptyset_\circ + \emptyset_1 \delta_t^2) r_{t-1} + \varepsilon_t \quad (5)$$

Eq.(5) – which dub as basic model - distinguishes between the part of autocorrelation due to market inefficiencies (denoted by $\emptyset_\circ$) and that due to feedback trading (denoted by $\emptyset_1$), which $\emptyset_1 = -\theta\gamma$ significantly positive (negative) values for $\emptyset_1$

will denote the presence of negative (positive) feedback trading. If $\emptyset_1 < 0$, it suggests the presence of positive feedback trading while negative feedback trading would be associated with $\emptyset_1 > 0$. This equation shows that the first order autocorrelation of returns varies with the level of risk in the market, δ_t^2, and in the case that positive feedback trading is present, this will lead to negative autocorrelation in returns. To assess the presence of leverage effects in volatility, the conditional variance (δ_t^2) in all of the above equations follows an asymmetric GJR-GARCH specification:

$$+\lambda\,\delta_{t-1}^2 + \eta I_{t-1}\varepsilon_{t-1}^2\delta_t^2 = \omega + \beta\varepsilon_{t-1}^2 \qquad (6)$$

where ε_{t-1}^2 and δ_{t-1}^2 are the previous period's squared shock and conditional variance respectively, δ captures the asymmetric response of volatility following positive and negative innovations and I_{t-1} is a binary variable equal to one if $\varepsilon_{t-1} < 0$ or zero otherwise. If $\boldsymbol{\eta} > 0$ negative shocks increase volatility more than positive shocks of the same magnitude then the leverage effect is said to be present.

The data used in this paper include the daily observations of the closing prices and NAV values of two available Saffron ETF in IME. The data covers the period[1] between January 3th, 2021 and November 21th, 2022 and has been obtained closing prices from Tehran Securities Exchange Technology Management Co (Tsetmc) and NAV from Fipiran, with the observations from both databases matched. The WinRATS 8.0 and Excel software was used, daily continuously compounded returns for the ETF series were then calculated as Eq. (7):

$$R_t = \log(P_t - P_{t-1}) \qquad (7)$$

Also, Eq. (8) is used to calculate ETF price deviation from its NAV:

$$\frac{P_t - NAV_t}{NAV_t} \times 100 \qquad (8)$$

Results and Discussion

As mentioned in introduction, it was stated that currently only two saffron ETFs are traded in the IME. Table 1 presents some statistics on each ETF's percentage price deviation from its NAV contingent on their sign (premium, if the sign is positive; discount, if it is negative).

The average percentage deviation of ETFs' prices from their NAVs is negative for both ETF, denoting that Saffron ETFs traded on average at a discount during the full sample period. The negativity of the average price deviation means that Saharkhaiz and Novira trade 19.9% and 21.5% less than their NAV, respectively. During the review period, the amount of discounts of Saharkhiz ETF is -10.90 percent and Novira ETF is -7.07 percent. In this period, the average deviation of the positive price of Saharkhiz ETF is 3.94% and Novira ETF is 1.91%. This shows that when traders favor Saffron ETFs, Saharkhiz ETF was traded with a higher price deviation than Novira ETF. Versus, Novira ETF has been traded with less price deviation when traders are not lucky. In total, Saharkhaiz and Novira ETFs have sprayed 88 and 80% of their days with discount, and 12 and 20% of their days with premium, respectively. In total, Saharkhaiz and Novira ETFs spent 88% and 80% of days with discount, and 12% and 20% of days with premium, respectively. These statistics show that the traders of Saffron ETFs do not pay attention to the NAV of this funds, or, their NAV has not been determined correctly, which leads to a large price deviation in the market of these funds. The historical changes of the price deviation of Saffron ETFs are presented in Fig. 1.

Table 1- Statistics on percentage price deviation from NAV

1- The start trading of Novira and Saharkhaiz ETFs is 2021/01/03 and 2021/01/20 respectively. The beginning of the time period is 2021/01/03.

ETF	Average price deviation (%)	Average discount (%)	Average premium (%)	% of days when ETF trades at a discount	% of days when ETF trades at a premium
Saharkhiz	-9.19	-10.90	3.94	88.44	11.56
Novira	-5.21	-7.07	1.91	79.57	20.43

Source: Research findings

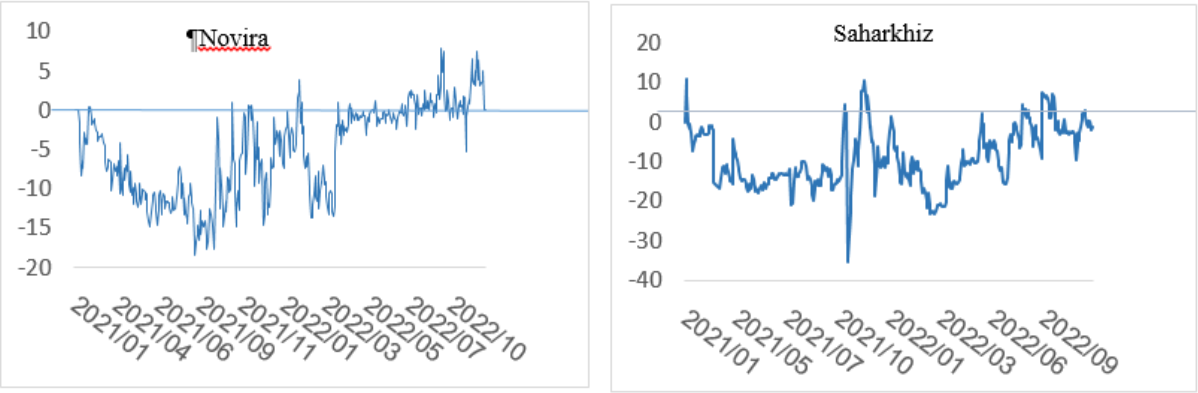

Figure 1- The historical changes of the price deviation of Saffron ETFs

Fig. 1. shows that on most days, both funds have discount. The highest amount of discount in Saharkhiz ETF is more than 35%. In the case of Novira ETF, this digit is more than 18%. Also, the highest premium in Saharkhiz ETF is more than 11% and in Novira ETF is 11%. Table 2 provides a series of descriptive statistics (mean, standard deviation, skewness kurtosis, Jarque-Bera normality test) pertaining to the log-differentiated returns of both ETFs.

Table 2- Descriptive statistics of Saffron ETFs

Statistics	ETF	
	Saharkhiz	Novira
Mean	0.14090	0.0992
Standard deviation	2.2994	2.3051
Maximum	8.9384	8.9160
Minimum	-8.8317	-9.5865
Skewness	0.5487	0.3027
Kurtosis	2.4363	2.2659
Jarque-Bera	126.1345	96.4905
Prob	0.0000	0.0000
Observations	424	421

Source: Research findings

Table 2 shows that during the reviewed period, Saharkhaiz ETF has provided its investors with a higher return than Novira ETF. The average return of Saharkhiz ETF is more than 0.14%, while this digit for Novira ETF is less than 0.10%. Both ETFs have positive skewness, which indicates the number of productive days compared to the number of days with positive returns. Also, the kurtosis of both ETFs is less than 3, which means that their distribution is shorter than the normal distribution. To examine the stationarity of Saffron ETFs, the Augmented Dickey-Fuller (ADF) unit root test has been used. The null hypothesis of this test is the existence of a uint root in ETF returns. If in this test, the computed value is greater than the critical value, the null hypothesis is rejected. Table 3 shows the results of ADF test statistic. According to the results, it is clear that the return of both Saffron ETFs in the level and whit existence intercept and trend are stationarity.

Table 3- Results of unit root test on Saffron ETFs (ADF)

ETF	Test type	Test level	t-statistic	Test critical values	Prob
Saharkhiz	Trend and intercept	Level	-14.92	-3.42	0.0000
Novira	Trend and intercept	Level	-14.86	-3.42	0.0000

Source: Research findings

ARCH test should be used to examine whether changes in ETF's current return depend on changes in the previous period or not. ARCH test is about the constant or variable variance of the error term. Before anything, it is necessary to perform the ARCH test on the variance of the error term. The ARCH tests the null hypothesis that no ARCH effects exist in the series and that it is an independently distributed series, the Results of ARCH test are given in Table 4.

Table 4- Results of ARCH test on Saffron ETFs

ETF	F-statistic	آمارهF	$LM = nR^2$	LM
Saharkhiz	54.27	0.0000	48.29	0.0000
Novira	99.45	0.0000	62.41	0.0000

Source: Research findings

According to the results of ARCH test in Table 4, the hypothesis of the existence of ARCH effects in the return of saffron ETFs cannot be rejected. As a result, both Saharkhiz and Novira ETFs have conditional heteroskedasticity. Now, according to the above results, the main model of Sentana and Wadhwani (1992) is estimated. The results of the estimation of the main model are indicated in Table 5.

Table 5- Parameter estimates for mean model with variance model GJR-GARCH

	Parameter estimates for mean Model				variance model Parameter estimates for			
ETF	α	θ	$\emptyset_0$	$\emptyset_1$	ω	β	λ	η
Saharkhiz	-0.085	0.052	-0.085	0.620	0.680	0.320	0.000	0.000
Prob	(0.542)	(0.551)	(0.886)	(0.867)	(0.024)	(0.297)	(0.663)	(0.607)
Novira	-0.076	0.030	0.191	0.005	0.411	0.767	0.140	0.025
Prob	(0.723)	(0.525)	(0.062)	(0.714)	(0.002)	(0.000)	(0.002)	(0.692)

Source: Research findings

According to results of Table 5, the volatilities of both ETFs do not respond significantly to news, with this response being symmetric in all cases, as the coefficient of η is always insignificantly. This means that positive and negative news have a uniform effect in increasing or decreasing the volatility in the return of Saffron ETFs. $\emptyset_1$ denoting the presence of feedback trading and it is not statistically significant for any of the Saffron ETFs. As a result, there is no evidence of feedback trading in Saffron ETFs, this means that the traders of this asset do not follow a specific pattern based on their previous return. Despit a formal market with full overlapping for the underlying assets, Saffron ETFs investors do not notice about the difference between ETFs' market prices and their NAVs and they trade only based on the supply and demand mechanism and market conditions. This is consistent with the results of Table 1 about the existence of a permanent price deviation between each ETF and its NAV. This findings are inconsistent with the findings of Wagner *et al*. (2022), Karra *et al*. (2021), Charteris and Kallinterakis (2021), Kallinterakis *et al*. (2020), Chen and McMillan (2020), Da Costa *et al*. (2019), Kyrkilis *et al*. (2018) and Kuttu and Bokpin (2017). $\emptyset_0$ indicates the existence of the return of ETFs based on market inefficiency that is not statistically significant for both ETFs, this means that the Saffron ETFs market is efficient. Due to the specificity of the underlying asset of these ETFs as the most expensive spice in the world, also, the food, medicinal and industrial

uses of saffron, its traders are a special part of investors in the market which is not only based on the previous return, rather they trade with the analysis and review of fundamental information. However, there are no Saffron ETF trading in any market in the world and Iran, as the largest producing country in the world, has the first Saffron ETF market.

Conclusion

Commodity ETF are one of the types of ETF that underlying assets are agricultural products, energy or metals instead of stocks. Evidence on the behavior of ETF traders has indicated that they subscribe to feedback style strategies. The objective of this paper is examine the feedback trading in behavior investors of Saffron ETF in Iran. For this purpose, daily data of two Saffron ETF for January 3, 2021 - November 11, 2022 and Sentana and Wadhwani (1992) was used. Examining the price deviation showed that these ETFs are traded at a price lower than their NAV on most trading days, and its traders do not pay attention to this difference. This situation shows the belief of most traders on the bubble of the underlying asset or pessimism about the performance of the ETFs. The results indicates positive and negative news have a uniform effect in increasing or decreasing the volatility in the return of Saffron ETFs. When information is published in the market of these ETFs, this news is more fundamental and traders are equally discriminating between published news. Also, results have no evidence of feedback trading in Saffron ETFs, and the traders of these ETFs do not pay attention to the previous day's return of these ETFs. It seems that the market of saffron ETFs in Iran is efficient and traders of these STFs are special part of investors, regardless of its previous return, they trade only based on the analysis and review of the available fundamental information. Since the trading of Saffron ETFs are not based on the feedback model, and traders do not only pay attention to the previous day's return, it is suggested that investors and portfolio managers use fundamental analysis and according to the factors influencing the price of Saffron, such as the amount of production, continental conditions, downturns and prosper and the export status of this product, trade and invest in these funds.

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مقاله پژوهشی

جلد ۳۷ شماره ۲، تابستان ۱۴۰۲، ص. ۱۴۳-۱۳۱

معاملات بازخورد در صندوق‌های قابل معامله زعفران

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تاریخ دریافت: ۱۴۰۱/۰۹/۲۳

تاریخ بازنگری ۱۴۰۲/۰۴/۱۰

تاریخ پذیرش: ۱۴۰۲/۰۴/۲۸

چکیده

صندوق‌های کالایی یکی از انوع صندوق‌های قابل معامله در بورس هستند که دارایی پایه آن‌ها به جای سهام، محصولات کشاورزی، انرژی و یا فلزات می‌باشند. این صندوق‌ها به روش‌های مختلفی نظیر نگه‌داری فیزیکی کالا، قرارداد آتی کالای منفرد، سبدی از قراردادهای آتی کالاها و یا خریداری سهام کالاهای مختلف، سرمایه‌گذاران خود را در مقابل بازار انواع کالاها قرار می‌دهند. طی سال‌های اخیر، این ابزار مالی با ایجاد مزیت‌های فراوان به یکی از گزینه‌های مهم سرمایه‌گذاری در بین معامله‌گران تبدیل شده است. با وجود این تحولات، شواهد کمی در ادبیات فعلی در مورد رفتار معاملاتی سرمایه‌گذاران این صندوق‌ها گزارش شده است. هدف از این مقاله، بررسی وجود معاملات بازخورد در رفتار معامله‌گران صندوق‌های کالایی زعفران در ایران می‌باشد. به این جهت از داده‌های روزانه دو صندوق زعفران موجود در بورس کالای ایران یعنی سحرخیز و نویرا، طی دوره زمانی ۱۳۹۹/۱۰/۱۴ الی ۱۴۰۱/۰۸/۳۰ و مدل معاملات بازخورد سنتانا-وادوانی (۱۹۹۲) استفاده شده است. نتایج حاصل نشان داد که نوسان بازدهی صندوق‌های زعفران نسبت به اخبار مثبت و منفی متقارن می‌باشد. با وجود بازار رسمی با هم‌پوشانی کامل برای معاملات دارایی پایه، معامله‌گران صندوق‌های زعفران توجهی به انحراف قیمت بین صندوق‌ها و خالص ارزش دارایی آن‌ها ندارند. نتایج حاصل از برآورد مدل معاملات بازخورد نشان داد که علائمی از وجود معاملات بازخورد در هیچ کدام از صندوق‌های زعفران دیده نمی‌شود و معامله‌گران این صندوق‌ها توجهی به بازدهی گذشته آن ندارند. به نظر می‌رسد بازار این صندوق‌ها از کارایی برخوردار می‌باشد که این موضوع را می‌توان با خاص بودن دارایی پایه زعفران و سرمایه‌گذاران این صندوق‌ها در ارتباط دانست.

واژه‌های کلیدی: صندوق‌های قابل معامله، صندوق‌های کالایی زعفران، معاملات بازخورد

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DOI: 10.22067/jead.2023.80030.1171

Journal of Agricultural Economics & Development

Homepage: https://jead.um.ac.ir

Full Research Paper
Vol. 37, No. 2, Summer 2023, p. 145-156

The Effect of Marketing Mix and Specialized Knowledge on the Export Performance of SMEs Exporting Dry Fruits

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Received: 18-01-2023
Revised: 22-07-2023
Accepted: 23-07-2023
Available Online: 24-07-2023

How to cite this article:
Yarmand, S., Mohammadi, H., Karbasi, A., & Dehghani, M. (2023). The effect of marketing mix and specialized knowledge on the export performance of SMEs exporting dry fruits. *Journal of Agricultural Economics & Development*, *37*(2): 145-156. https://doi.org/10.22067/jead.2023.80703.1176

Abstract

Export is a crucial driver of economic growth in various countries and significantly contributes to a country's entry into global markets and enhances economic success. In developing countries such as Iran, economic and social development programs prioritize the expansion of exports, particularly high value added agricultural products. The growth in non-oil exports, such as dried fruits, and the entry of domestic producers into new global markets have led to an increased demand for Iran's export products. This has also resulted in higher production levels, increased employment opportunities, and higher value added in the related activities. To enhance export performance, which is a crucial measure of a company's success in utilizing its resources and capabilities in the international arena over a specific period of time, it is important to focus on improving marketing strategies and specialized knowledge. Therefore, this research aims to examine the impact of marketing mix and specialized marketing knowledge on the export performance of small and medium-sized enterprises (SMEs) involved in exporting dried fruits in Mashhad, Iran in 2022. A total of 80 questionnaires were distributed among senior managers, board members, and business managers of dried fruits SMEs using the available sampling method. Structural equation modeling was employed for data analysis and test of research hypotheses. The statistical data and structural equation modeling revealed that the joint impact of marketing mix and specialized marketing knowledge has a positive and significant influence on export performance. In order to improve the company's profitability, it is essential for senior managers and sales managers to recognize the significance of these two factors and undergo relevant training to acquire the necessary skills. Moreover, managers should make effective use of appropriate distribution channels to expand their exports. Simultaneously, they should consider adapting product quality and packaging to align with the preferences of foreign buyers.

Keywords: Dried fruit, Export, Export performance, Marketing mix, Structural equation
JEL classification: C12, M30, Q13

Introduction

Export plays a crucial role in enabling companies to expand their sales and profitability in the global markets. Achieving exceptional performance in exports is an importance objective for both the private and public sectors. By increasing exports, employment opportunities are created, social welfare is enhanced, and standards of living could be improved. Moreover, it leads to higher productivity, income generation, and development of national industries (Bashir

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DOI: 10.22067/jead.2023.80703.1176

Khodaparasti *et al.*, 2020). Despite the significance of exports in a country's economy, domestic and global restrictions and environmental changes often pose challenges for exporting companies. These challenges necessitate long-term planning to overcome the problems facing companies effectively. International exporters must adopt long-term strategies to ensure their participation in the global market and ensure satisfactory profits (Morgan *et al.*, 2004).The export of non-oil products, such as dried fruits, contributes significantly to economic growth and increasing value added through various ways in some developing countries such as Iran. These include attracting foreign exchange, stimulating production, reducing average production costs, capitalizing on economies of scale, and leveraging the country's relative advantages (Rahim Nia and Sadeghian, 2011). According to statistics from 2019, in Iran, the total export volume of non-oil goods (excluding luggage) reached 113,189 thousand tons with a value of 34,861 million dollars. However, this represents a decline of 15.41% in weight and 14.97% in value compared to 2018 (Islamic Republic of Iran Customs Administration, 2020).

Table 1-Non-oil exports of goods (excluding luggage trade) during t 2016-2020 in Iran (Weight and Value)

Year	The amount of export		Percentage changes compared to the previous years
2016	Weight*(thousand tons)	129892	38.32
	Value*(million dollars)	44042	3.80
2017	Weight(thousand tons)	132882	2.30
	Value(million dollars)	46982	6.68
2018	Weight(thousand tons)	117961	11.22
	Value(million dollars)	44667	4.92
2019	Weight(thousand tons)	133813	13.88
	Value(million dollars)	40669	7.26
2020	Weight(thousand tons)	113189	15.41
	Value(million dollars)	34861	14.97

Source: Iran Customs Administration, * Weight in thousand tons and Value in million dollars

Table 1 shows that non-oil exports have experienced a significant decline during 2016-2020 in Iran. This decline poses a threat to both the private and government sectors in the international market, ultimately leading to a decrease in overall exports and declining economic growth. In order to survive and improve this condition of exports, the private sector must embrace innovation, competition, and creativity. The international economic system relies much on the participation of the private sector, with most economic activities entrusted to them (Ahad Motlaqi and Saifi Asl, 2017).

Furthermore, the food industry sector (specifically dry fruits) have a great potential, accounting for 11% of non-oil product exports (Statistics of the Ministry of Agriculture Jihad, 2019).

Therefore, understanding the challenges faced by small and medium-sized enterprises exporting dry fruits is crucial for increasing export volumes and export value of them. Additionally, small and medium-sized enterprises (SMEs) play a vital role in business development and accessing global markets (Bianchi and Wickramasekera, 2016). These companies play a crucial role in global economic growth, as they possess varying levels of capital, workforce, number of products, and financial turnover. However, they also face with several challenges when it comes to exporting. These challenges include financial issues, an imbalance between the country's industrial growth and international industrial development, a lack of understanding of foreign markets and global economic transformations, as well as a lack of experience in international affairs such as negotiation methods, contract agreements, and legal matters. These

challenges significantly impact the export performance of these companies (Rahmany Youshanlouei *et al*., 2016). For small and medium-sized exporters, it is essential to have a clear goal of connecting with the global market and then determining the company's objectives and strategies to achieve them. It is important to note that export marketing goes beyond simply finding buyers or importers in the target country; it also involves effectively implementing protocols outlined in a well-structured plan to ensure success in global markets (Nilipour Tabatabai and Ismailzadeh, 2014).

Export performance serves as a vital indicator for measuring the success of a company's export activities (Beleska and Spasova, 2014). It refers to the extent to which a company achieves its goals when exporting products to foreign markets (Faryabi et al., 2017). To achieve success in exporting and competing in global markets, export companies must fully utilize their resources and facilities to establish a strong presence. The measurement of export performance encompasses both quantitative and qualitative variables (Qaldati and Movasagh, 2017). Export performance is influenced by various factors, including marketing mix, knowledge management activities, export innovation, and specialized marketing knowledge. The marketing mix comprises controllable marketing variables that the company combines to cater to the target market. Essentially, it encompasses all the activities undertaken by the industry or company to influence product demand (Qudousi *et al*., 2014). The marketing mix emphasizes the effective utilization of four components: product, price, distribution, and promotion (Mahmoudi *et al*., 2018).

Marketing knowledge management pertains to a specific area of knowledge that relates to an organization's marketing processes (Rahimpour and Rohbakhsh, 2021). Hence, it has the potential to impact the overall performance of an organization. Specialized marketing knowledge plays a crucial role in various aspects such as generating new ideas and products tailored to individual customers, understanding the target market and customer preferences, building trust with customers, reducing problem-solving time, and implementing effective marketing strategies (Karampour and Ebrahimi, 2014). Given that enhancing export performance for companies involved in international trade leads to currency gains and improves the country's commercial standing, it is essential to consider factors that influence export performance. Therefore, this research aims to investigate the factors that contribute to improving the export performance of small and medium-sized companies in the dry food industry operating in foreign markets. Additionally, within non-oil products, the food industry sector holds significant export potential in Iran. In 2019, Iran's dried fruit exports reached 776 thousand tons with a value of 2036 million dollars according to statistics from the Customs Organization of the Islamic Republic of Iran. Khorasan Razavi province alone contributes approximately 4.5% of the country's dried fruit exports by weight, with notable production capacities for products like saffron (300.94 tons), pistachios (87437 tons), raisins (357026 tons), and other dried fruits (59000 tons) (Ministry of Agriculture Jihad Statistics, 2019). The potential of the sector in ensuring the country's commercial position in international markets highlights the need for further investigation. Previous research in this field has overlooked important aspects such as strategic orientation, specifically the "marketing mix" and "specialized marketing knowledge." This study aims to address this gap by examining and evaluating these dimensions. The research focuses on small and medium-sized companies in Khorasan-Razavi province, known for its dry fruit production and export. The study area is Mashhad city, which has a significant number of active companies involved in exporting these products.

Despite previous research on export performance, international companies still encounter challenges in this area (Faryabi *et al*., 2019). Evaluating a commercial company's success in exporting can be done by assessing its performance and export function (Cavusgil and Zou, 1994). Export performance refers to

the outcomes of an organization's activities in export markets (Sousa Carlos, 2005). In a study conducted by Altern and Todran (2015), the impact of customer orientation on export performance was examined. The researchers also considered company size and environmental uncertainties as additional variables. The findings revealed that the relationship between exporter's customer orientation and the customer's ability to pay is fully explained by behavioral commitment and communication. In another study by Ndiaye *et al*. (2018), the performance of small and medium enterprises (SMEs) in emerging and developing economies was investigated. The researchers examined indicators based on 80 potential factors derived from various aspects such as company characteristics, finance, informal factors, infrastructure, innovation, technology, regulation, tax, trade, and labor in SMEs. The data analysis results indicated that the use of email for interactions with customers or suppliers had a positive impact on annual employment growth for medium-sized companies but not for small companies. Behzadnia and Sanoubar (2018) conducted a research with a focus on entrepreneurial companies exporting agricultural products from Iran. The findings indicated that the impact of marketing capabilities on a company's export performance is not direct, but rather indirect through the creation of competitive advantages. It was found that marketing capabilities directly influence competitive advantages, which in turn directly affect export performance. Sinkovics *et al*. (2018) conducted a study on small and medium exporting companies, revealing that export experience and commitment reduce both domestic and foreign export barriers for managers of SMEs based in England. In another study Bakhtiari and Bakhshandeh (2019) examined variables such as export commitment, perceived market distance, pre-export issues, and marketing mix adaptation, all leading to export performance. The results demonstrated a significant and positive relationship between marketing mix adaptation and export performance. Gupta and Chauhan (2020) explored the environmental factors influencing foreign trade in both developing and developed countries. Their results revealed that innovation, marketing, and network capabilities have a positive impact on the export performance of small companies. Additionally, the research clarified the significance of these capabilities in enhancing export performance across various industries for small and medium-sized enterprises. Aghazadeh *et al*. (2020), examined the influence of organizational factors such as relationship quality, competitor orientation, customer orientation, and market orientation on export performance. They specifically focused on the company's commitment to exporting. Their findings indicated that three factors - customer-centered approach, market-centered approach, and competitor-centered approach - were positively correlated with export performance. However, there was no relationship between quality and export performance. Another study by Amoamoha and Yazdani (2022), investigated the impact of marketing capabilities on export performance. The researchers also examined how competitive strategy, positional advantage, bilateral innovation, and marketing capabilities interacted with each other. The results demonstrated that strengthening marketing capabilities and leveraging positional advantage can enhance export performance. Overall, both studies highlight the importance of innovation, marketing capabilities, competitive strategy, and positional advantage in improving the export performance of companies. Mohammadi *et al*. (2019), showed that marketing strategies of differentiation, market development, and product development had a significant positive effect on the export performance of saffron companies in Iran.

The background review of the research indicates that various factors, such as the marketing mix and marketing strategies significantly impact export performance. Additionally, possessing specialized marketing knowledge plays a crucial role in achieving success and influencing the export performance of companies. Given the significance of dry fruit exporting companies in the realm of

exports and the lack of sufficient studies and research in the field of dry fruit export, this study aims to examine the influence of two important variables - marketing mix and specialized marketing knowledge - on the export performance of SMEs active on dry fruit export in Mashhad in 2022.

Methodology and Data

This research focuses on analyzing the factors that impact the export performance of SMEs in Mashhad's food industry, specifically, those involved in exporting dry food products. The research was conducted in Mashhad city and involved interviews and questionnaires to establish relationships between variables. The target population consisted of senior managers, board members, and business managers from SMEs engaged in the export of dry food products in Mashhad. To ensure convenience and maximize effectiveness, an availability sampling method was employed. Out of the 87 active dry fruit export companies in Mashhad, 80 questionnaires were distributed among senior managers and business managers. Ultimately, 52 completed questionnaires were returned and considered for analysis, while the remaining questionnaires were disregarded due to non-completion or non-return. The research questionnaire consists of two parts: general information and specialized information. The questions in the questionnaire are presented in a spectrum and multiple-choice format. The hypotheses related to the impact of marketing mix and specialized knowledge were tested using Structural Equation Modeling (SEM). The analysis and interpretation of the structural equation model were conducted in two stages: first, the measurement model was examined, followed by the analysis of the structural model. The measurement model aimed to assess the weights and loadings of the underlying variables, while the structural model focused on examining the path coefficients between these variables (Fornell and Lacker, 1981). Descriptive statistics were employed to analyze demographic characteristics, while inferential statistics were used for analyzing data at the level of structural equation modeling. The software tools utilized for data analysis were SPSS 26 and Smart Pls3.

Data and variables

In order to assess the factorial validity of the questionnaire, two statistical tests were conducted: the KMO index and Bartlett's significance test of sphericity. The findings are presented in Table 2. The KMO index serves as a measure of sampling adequacy, ranging from zero to one. A value close to one indicates that the data is suitable for factor analysis, while a value typically below 0.5 suggests that the factor analysis results may not be appropriate for the given data. Both Bartlett's test and the KMO index were used as indicators of sampling adequacy, and the results indicate favorable levels for both measures. Specifically, all variables had KMO values exceeding 0.5, and Bartlett's test yielded a significance value below 0.05

Once the sample size was confirmed to be appropriate, we proceeded to analyze the factor loading of the items. Additionally, we assessed the reliability of the questionnaire by employing Cronbach's alpha coefficient. The obtained values exceeded 0.7, indicating that the measurement tool possesses the necessary reliability. These results are presented in Table 3.

The first step in the structural equation method involves evaluating the research measurement model. This entails determining whether the observed variables accurately measure the theoretical concepts. To assess construct validity, two measures are used: convergent validity and divergent validity. Convergent validity is confirmed when factor loadings exceed 0.5 and the AVE index is above 0.5. The AVE index ensures that at least 0.5% of the variance in a construct is accounted for by the items used to define it. The results of this index are reported in Table 4. Divergent validity is established when the correlation value between two variables is lower than a specified threshold value. The results of this index are reported in Table 5.

Table 2- Results of confirmatory factor analysis of questionnaire items

Variable name	Dimensions	Object	Operational burden	KMO	Variance explained	Bartlett's test
Marketing mix	Product	pro1	0.884	0.817	0.781	0.000
		pro2	0.895			
		pro3	0.895			
		pro4	0.860			
	Price	pri1	0.865	0.778	0.728	0.000
		pri2	0.836			
		pri3	0.834			
		pri4	0.879			
	Place	pla1	0.820	0.691	0.748	0.000
		pla2	0.675			
		pla3	0.751			
	Promotion	promo1	0.796	0.698	0.741	0.000
		promo2	0.661			
		promo3	0.768			
Marketing expertise	–	kno1	0.712	0.924	0.758	0.000
		kno2	0.815			
		kno3	0.800			
		kno4	0.783			
		kno5	0.740			
		kno6	0.798			
		kno7	0.722			
		kno8	0.722			
		kno9	0.818			
		kno10	0.719			
		kno11	0.736			
		kno12	0.734			
Export performance	–	performance1	0.837	0.697	0.792	0.000
		performance2	0.928			
		performance3	0.903			

Source: Research findings

Table 3- Cronbach's alpha coefficient of the main research variables

Variables	Cronbach's alpha of the variables
Marketing mix	0.968
Marketing expertise	0.971
Export performance	0.862

Source: Research findings

Following the verification of convergent validity and divergent validity, the research measurement model was deemed valid. Subsequently, after analyzing and confirming the measurement model, the fit of the structural model was evaluated. This evaluation encompassed the examination of the second stage of path analysis, which includes assessing the coefficient of determination and the model suitability index. Path analysis involves studying relationships between variables in a one-directional flow, represented by distinct paths. The path diagram, as depicted in Fig. 1 and Fig. 2, illustrates potential causal links between variables (Bakhtiari and Bakhshandeh, 2019).

Table 4- **Convergent validity results of the research**

Variable name	Object	Operational burden	Statistics t	Result	AVE
Marketing mix	Product	0.714	2.156	Meaningful	0.624
	Price	0.714	2.156	Meaningful	
	Place	0.882	4.517	Meaningful	
	Promotion	0.835	2.156	Meaningful	
Marketing expertise	kno1	0.854	20.429	Meaningful	0.758
	kno2	0.908	26.703	Meaningful	
	kno3	0.894	19.477	Meaningful	
	kno4	0.883	17.973	Meaningful	
	kno5	0.857	17.744	Meaningful	
	kno6	0.889	19.028	Meaningful	
	kno7	0.846	15.627	Meaningful	
	kno8	0.844	13.259	Meaningful	
	kno9	0.900	20.628	Meaningful	
	kno10	0.845	20.429	Meaningful	
	kno11	0.860	13.903	Meaningful	
	kno12	0.864	14.662	Meaningful	
Export performance	performance1	0.811	8.101	Meaningful	0.791
	performance2	0.936	12.281	Meaningful	
	performance3	0.916	12.541	Meaningful	

Source: Research findings

Table 5- Divergent validity

Variables	1	2	3
Export marketing mix	0.790		
Marketing expertise	0.225	0.781	
Export performance	0.296	0.344	0.889

Source: Research findings

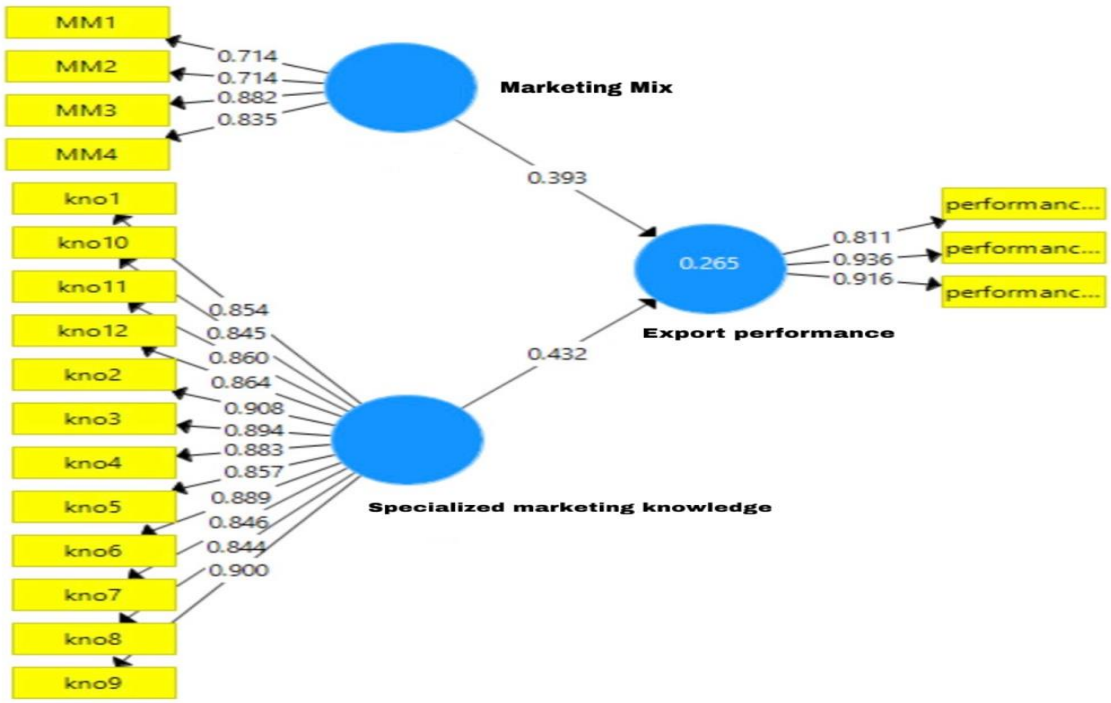

Figure 1- Conceptual model fitted in standard estimation mode

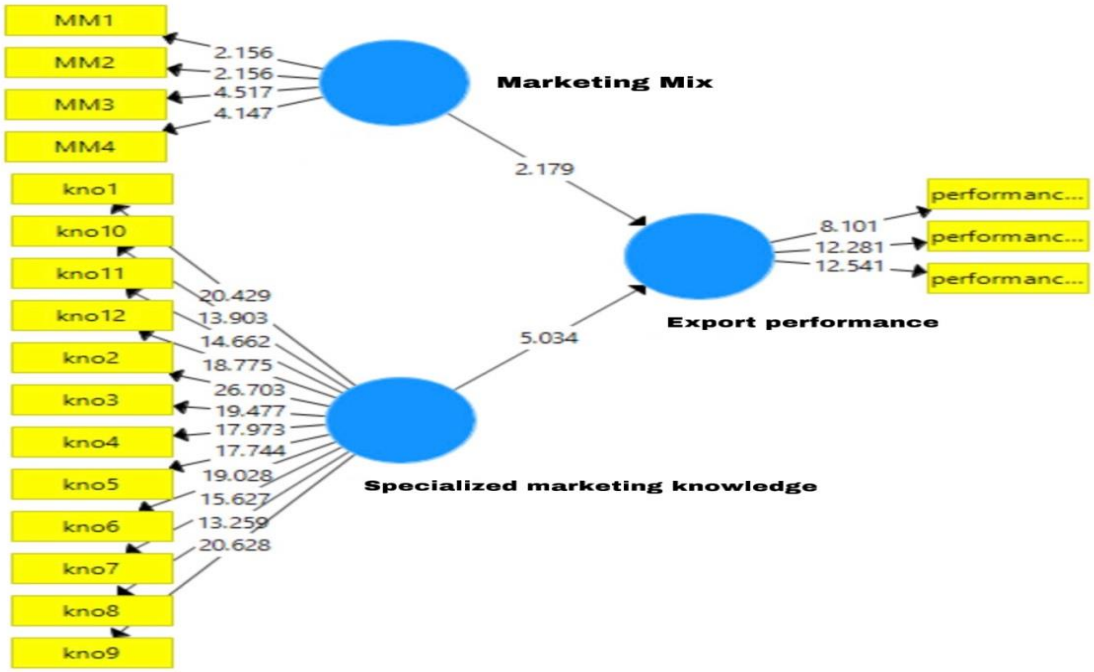

Figure 2- Conceptual model fitted in the significance mode of parameters

Moving forward, this section discusses the research hypotheses and their corresponding tests. To confirm or reject these hypotheses, t-Student's test statistic was utilized. If the t statistic value exceeds ±1.96, the hypothesis is confirmed at a significance level of 0.05; otherwise, it is rejected. The first main hypothesis examines whether marketing mix has a positive and significant impact on export performance. The examination of this relationship among SMEs exporting dried fruit products in Mashhad reveals a coefficient of effect between these two variables equal to 0.393 (as shown in Table 6). The t statistic for this path coefficient is calculated as 2.179, surpassing the critical value of 1.96. Consequently, it can be concluded that this path coefficient is significant at a significance level of 0.05.

Table 6- Regression coefficient and significance of the effect of marketing mix and specialized marketing knowledge on export performance

Hypothesis	Direct route	Regression coefficient	T	Result
1	Export marketing mix → Export performance	0.393	2.179	confirmation
2	Specialized marketing knowledge → Export performance	0.432	5.04	confirmation

Source: Research findings

The second hypothesis states that specialized marketing knowledge has a positive and significant impact on export performance. The study conducted in Mashhad on small and medium-sized dry fruit exporting companies reveals that the coefficient of effect between specialized marketing knowledge and export performance is 0.432, as shown in Table 6. The t statistic value for this path coefficient is 5.04, which exceeds the critical value of 1.96. Therefore, it can be concluded that this path coefficient is statistically significant at the 0.05 level of significance. Furthermore, both the marketing mix hypothesis and the specialized marketing knowledge hypothesis were confirmed at a 95% confidence level for testing research hypotheses.

Conclusions and Suggestions

The purpose of this study was to examine the

impact of marketing mix and specialized marketing knowledge on the export performance of small and medium dry fruit exporting companies in Mashhad, Iran. Two hypotheses were tested regarding export performance. The first hypothesis, which stated that marketing mix components have a positive and significant effect on export performance, was supported by the results. In SMEs, the marketing mix is a collection of tools that aims to generate more profit for the company compared to its competitors by utilizing an innovative approach and combining price, product, promotion, and place. The second hypothesis, which suggested that specialized marketing knowledge has a positive and significant effect on export performance, was also confirmed by the findings. Therefore, sales managers are advised to utilize marketing plans and strategies (specialized marketing knowledge) to increase sales and profitability. These strategies are considered as new tools in the strategic marketing planning process within marketing management. Additionally, managers should thoroughly analyze both the internal and external environment, formulate an appropriate strategy based on internal strengths and weaknesses as well as external opportunities and threats, and evaluate its effectiveness accordingly (Sulaimanpur and Valizadeh, 2012).

Based on the findings, the senior managers and marketers of dry fruit exporting companies in Mashhad are advised to take the following actions: Recognizing the importance of the regression coefficient (0.393) indicating the impact of marketing mix on export performance, it is recommended that companies engage marketing and economics experts to utilize suitable marketing strategies in foreign markets based on target market needs. This can be achieved by enhancing product quality, branding, packaging, competitive pricing, distribution channels, and actively participating in international exhibitions. These efforts will enable companies to secure a favorable market share in their target markets.

The path coefficient for the impact of specialized marketing knowledge on export performance is 0.432, which consistent with the findings of (Karampour and Ebrahimi, 2014). This study concluded that there is a positive and significant relationship between technical knowledge innovation and export performance. Therefore, it is advisable for senior managers and sales officials to acquire additional training in order to enhance their specialized sales skills and marketing knowledge. This will enable them to utilize up-to-date marketing methods, ultimately leading to increased profits for companies. In the medium term, companies can improve their export performance by implementing strategies such as market segmentation, targeting high-income countries, and penetrating new markets. To sustain exports, it is crucial to understand the attitudes of foreign buyers and engage in advanced marketing activities. These efforts, coupled with government support and uninterrupted export operations, can contribute to the growth of exports across various product categories. Considering that factors like exchange rate fluctuations, epidemic outbreaks (such as COVID-19), political relations, embargoes, etc., have an impact on export performance, future studies should explore these aspects in greater detail.

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مقاله پژوهشی

جلد ۳۷ شماره ۲، تابستان ۱۴۰۲، ص. ۱۵۶-۱۴۵

اثر آمیخته بازاریابی و دانش تخصصی روی عملکرد صادرات شرکت‌های کوچک و متوسط صادر کننده خشکبار

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تاریخ دریافت: ۱۴۰۱/۱۰/۲۸

تاریخ بازنگری ۱۴۰۲/۰۴/۳۱

تاریخ پذیرش: ۱۴۰۲/۰۵/۰۱

چکیده

صادرات محرک حیاتی رشد اقتصادی در کشورهای مختلف است و به طور قابل توجهی به ورود یک کشور به بازارهای جهانی کمک می‌کند و موفقیت اقتصادی را افزایش می‌دهد. در کشورهای در حال توسعه مانند ایران، برنامه‌های توسعه اقتصادی و اجتماعی، گسترش صادرات به‌ویژه محصولات کشاورزی با ارزش افزوده بالا را در اولویت قرار داده‌اند. رشد صادرات غیرنفتی مانند خشکبار و ورود تولیدکنندگان داخلی به بازارهای جدید جهانی منجر به افزایش تقاضا برای محصولات صادراتی ایران خواهد شد. این امر همچنین منجر به افزایش سطح تولید، افزایش فرصت‌های شغلی و ارزش افزوده بیشتر در فعالیت‌های مرتبط می‌شود. برای افزایش عملکرد صادرات، که معیاری حیاتی برای موفقیت یک شرکت در استفاده از منابع و قابلیت‌های خود در عرصه بین‌المللی در یک دوره زمانی خاص است، تمرکز بر بهبود استراتژی‌های بازاریابی و دانش تخصصی بسیار مهم است. بنابراین، این تحقیق با هدف بررسی تاثیر آمیخته بازاریابی و دانش تخصصی بازاریابی بر عملکرد صادرات شرکت‌های کوچک و متوسط فعال در صادرات میوه‌های خشک مشهد در سال ۱۴۰۱ انجام شد. در مجموع ۸۰ پرسشنامه با استفاده از روش نمونه‌گیری در دسترس بین مدیران ارشد، اعضای هیئت مدیره و مدیران بازرگانی SME های میوه خشک توزیع شد. برای تجزیه و تحلیل داده‌ها و آزمون فرضیه‌های تحقیق از مدل‌سازی معادلات ساختاری استفاده گردید. داده‌های آماری و مدل‌سازی معادلات ساختاری نشان داد که تأثیر مشترک آمیخته بازاریابی و دانش بازاریابی تخصصی بر عملکرد صادرات مثبت و معنادار است. برای افزایش سودآوری شرکت، برای مدیران ارشد و مدیران فروش بسیار مهم است که این دو عامل را به رسمیت بشناسند و برای کسب مهارت‌های لازم، آموزش‌های مربوطه را طی کنند. علاوه بر این، مدیران باید از کانال‌های توزیع مناسب برای افزایش صادرات خود استفاده کنند و در عین حال کیفیت و بسته‌بندی محصول را بر اساس ترجیحات خریداران تطبیق دهند.

واژه‌های کلیدی: آمیخته بازاریابی، خشکبار، صادرات، عملکرد صادراتی، معادلات ساختاری

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DOI: 10.22067/jead.2023.80703.1176

Journal of Agricultural Economics & Development

Homepage: https://jead.um.ac.ir

Full Research Paper
Vol. 37, No. 2, Summer 2023, p. 157-176

Freedom and Environmental Performance: Evidence from MENAT Countries

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Received: 04-04-2023	**How to cite this article:**
Revised: 15-07-2023	Alavi, S.E., & Mohammadi, M. (2023). Freedom and environmental performance: evidence from MENAT countries. *Journal of Agricultural Economics & Development, 37*(2): 157-176. https://doi.org/10.22067/jead.2023.81572.1184
Accepted: 17-07-2023	
Available Online: 17-07-2023	

Abstract

Environment quality and its determinants are one of the main challenges of the present and future of humanity and sustainable development is interpreted in the direction of preserving and improving the environment. In recent years, many studies have been conducted on the factors affecting environmental quality. One of the main topics that have been less considered in the related studies is the impact of governance on the quality of the environment. In this study, the impact of good governance components, including economic freedom, trade freedom, and political freedom, on the Environmental Performance Index (EPI) and its sub-indices including environmental health, ecosystem vitality, and climate change is investigated. The data required for statistical analysis are related to Middle East and North Africa region countries and Turkiye (MENAT) during 2000-2021. The panel data method was used to estimate the model and examine the relationship between the variables. The findings show that there is a positive and significant relationship between economic freedom and political freedom with the environmental performance index (EPI), and there is no significant relationship between trade freedom and EPI. In addition, the study found that economic freedom had a detrimental effect on ecosystem vitality and climate change, leading to negative impacts in these areas. However, it had a positive impact on environmental health, indicating that it contributed positively to this aspect. On the other hand, political freedom was observed to have a positive effect on the vitality of the ecosystem and climate change. However, it did not have a significant impact on the overall health of the environment, suggesting that its influence was more prominent in specific areas related to ecosystem vitality and climate change. The result of this research showed that economic freedom has led to more investment in the oil and gas sector of MENA countries, and therefore wastewater and gas emissions have had a negative impact on the vitality of the environment and climate change, but with the increase in production and sales of oil and Gas, per capita income of countries has increased, and environmental health has improved. Also, considering that political freedom among the MENA region has a lot of diversity, the results showed that the countries with more political freedom, through greater awareness of the society and more accountability of the governments and the establishment of environmental protection laws, had a positive impact on the environment. Of course, the environmental health index is more influenced by the economic situation and per capita production of countries and political freedom has little effect on it.

Keywords: Environmental performance, Economic freedom, Political freedom

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DOI: 10.22067/jead.2023.81572.1184

Introduction

One of the most important issues that have been investigated in recent decades is the quality of the environment. In fact, the environmental problems that have occurred in the past several decades and their effects on economic performance have been resulted in investigation of factors affecting the destruction of the environment (Rapsikevicius *et al.*, 2021; Olasky *et al.*, 2019; Pourali *et al.*, 2019). The longevity of general environmental indicators, which serve as markers for assessing environmental quality, typically does not extend beyond two decades. Prior to this period, many environmental analyses primarily focused on key indicators, such as CO2 levels, as well as the pollution of water and soil. About three decades ago, efforts to build an index that covers various aspects of the environment and can get a general view of the state of the environment at any point in time were put on the agenda of scientific institutions (Hsu and Zomer, 2016).

One of the most successful efforts in this field has been the design and calculation of the Environmental Performance Index (EPI) for different countries, which has been carried out by Yale and Columbia universities with the collaboration of the European Commission Research Center since 2000. By using 40 indicators in 11 different environmental fields, this index has been able to have one of the most comprehensive attitudes towards the categories of the environment performance. The purpose of calculating this index is to provide a quantitative measure for evaluating the environmental performance of different policies. This index is a weighted average of 22 performance indicators in 40 policy groups, including the environmental burden of diseases, air pollution (effects on human health), water pollution (effects on the ecosystem and effects on human health), water resources (effects on the ecosystem), biodiversity and animal and plant habitats, changes in forestry, changes in fishing, changes in agriculture, and changes in climate (Wolf *et al.*, 2022). The comprehensiveness of this index compared to CO_2 and SO_2 or air pollution levels or climate changes have helped to test the effects of different policies more accurately (Hsu and Zomer, 2016; Wolf *et al.*, 2022). After the introduction of EPI, finding the factors that affect this index and the performance of the environment has become important among the experts of various sciences and economists have also discussed the economic factors affecting EPI. Among the economic factors investigated, some influential variables exhibit complex and non-linear effects on the Environmental Performance Index (EPI). For instance, as per Kuznets' hypothesis, both Gross National Product (GNP) and per capita income tend to have a negative correlation with EPI at lower income levels, while at higher income levels, this correlation becomes positive. Additionally, variables like the share of the agriculture sector in Gross Domestic Product (GDP), the level of the Human Development Index (HDI), the ratio of urbanization, and energy consumption intensity can exert diverse effects on environmental quality under varying conditions. These effects may differ depending on specific contexts and circumstances. (Filimonova *et al.*, 2020; Lotfalipour *et al.*, 2010; Shahabadi *et al.*, 2017). However, one of the most important variables whose effects have been studied on various sectors, including the environment, is freedom. During the last decades, economists have examined freedom from different aspects and have shown the effects of its types such as political freedom (are included political rights and civil liberties), economic freedom (are included property rights, government integrity, government spending, business freedom, labor freedom, investment freedom, financial freedom, …), and trade freedom (a composite measure of the absence of tariff and non-tariff barriers that affect imports and exports of goods and services) on the quality of the environment and its different sectors (Rapsikevicius *et al.*, 2021; Carlsson and Lundström, 2003; Sart *et al.*, 2022).

Moreover, the effects of different types of freedom on the quality of the environment have not been investigated in detail and the effects of different types of freedom have been presented

in different countries and regions with sometimes inconsistent results and interpretations (Filimonova *et al*., 2020; Prathibha and Beck, 2018). Therefore, it is necessary to test the effect of different aspects of freedom on variables such as the environment in different regions and at different times so that the results are more reliable. In addition, although there have been studies on the relationship between various types of freedom, such as political freedom, economic freedom, and trade freedom, with environmental indicators, the impact of all aspects at the same time has been less discussed. In fact, considering the synergies that different freedoms have on each other, which is caused by the intellectual system governing different countries, the results can be more valid if they are examined at the same time.

The MENAT region (the countries of the Middle East and North Africa region including Algeria, Bahrain, Egypt, Iran, Jordan, Kuwait, Lebanon, Morocco, Oman, Qatar, Saudi Arabia, Tunisia, United Arab Emirates and Turkey) can be used as a model of the same structure and different attitudes due to some characteristics such as the relative possession of an ideological structure (Islam) and of course with different perceptions in the field of different freedoms; So, they are similar to each other in terms of the dependent variable. In addition, the presence of rich natural resources, especially oil resources, in these areas and different environmental effects, increases the need for environmental studies in this area (Farzanegan and Markwardt, 2018). For examples in 2018 the MENA region emitted 3.2 billion tonnes of carbon dioxide and produced 8.7% of global greenhouse gas emissions despite making up only 6% of the global population. These emissions are mostly from the energy sector, an integral component of these economies due to the extensive oil and natural gas reserves that are found within the region. Also this region is one of the most vulnerable to climate change. The impacts include increase in drought conditions, aridity, heatwaves and sea level rise (Global Carbon Atlas, 2020; Rana Alaa *et al*., 2017).

In this context, this study's significant contribution lies in its comprehensive examination of the impacts of various forms of economic, political, and trade freedoms, as assessed through indicators provided by international organizations, on the environmental performance of MENAT (Middle East, North Africa, and Turkey) countries, all in a single analysis. This research offers valuable insights to policymakers, enabling them to make informed decisions aimed at fostering a healthier and more sustainable environment. In fact, the main goal of this study is to investigate the effects of economic, political, and trade freedoms of the MENAT countries on the quality of their environmental performance.

According to the data structure and the goal of the study, the panel data approach has been chosen to investigate the research problem. Therefore, a review of the theoretical foundations of the research and a literature review will be carried out to determine the theoretical relationship between the independent variables of the research with EPI. Then by introducing the research variables, the structure of the research model is determined. Next, with appropriate tests, the optimal model is estimated, and the obtained results are analyzed.

While numerous studies have previously explored the individual effects of different types of freedom on environmental performance and climate change, this study seeks to contribute to the discourse by simultaneously analyzing the combined impact of various freedoms in the MENAT region. This region is particularly significant due to its involvement in various environmental issues. Moreover, this research extends its investigation to examine how these freedoms affect the sub-indexes of environmental performance, thus providing a more comprehensive understanding of their influence.

Literature review and theoretical background

Although many studies have been conducted in the field of the relationship between freedom and the environment in recent years, most of these studies have examined the impact of certain types of freedom on the specific indicators of the environment such as CO_2 emission, air pollution, and climate change. In the following, the impact of each type of freedom on the environment is discussed and some of the most important experimental studies conducted in this field are also mentioned.

Economic freedom is one of the types of freedom that significantly impacts environmental quality, and it has been the subject of investigation in numerous studies. The effects of economic freedom are often regarded as intermediary variables in economic theories, and they manifest their influence on the environment through various mechanisms. These mechanisms include the enhancement of income levels, income distribution, institutional quality, incentives, and overall efficiency. Consequently, economic freedom plays a pivotal role in shaping environmental outcomes and sustainability. (Carlsson and Lundström, 2002; Babaki and Elyaspour, 2021; Miller *et al*., 2022; Magnani, 2000; Bernauer and Koubi, 2013). Moreover, economic freedom is a combination of indicators of property rights, judicial quality, government honesty, the share of government spending in the economy, financial health, monetary freedom, labor market freedom, business freedom, financial freedom, commercial freedom, Investment freedom and financial freedom (Miller *et al*., 2022).

In the economic literature, various channels through which economic freedom impacts the environment have been examined. These channels are often categorized based on different dimensions of economic freedom and provide insights into how economic freedom can influence environmental outcomes. The first path is known as efficiency. Here, economic freedom leads to the creation of more efficient and competitive markets, and due to the more efficient use of resources, the quality of the environment improves (Carlsson and Lundström, 2002; Chang and Wang, 2012; Wood and Herzog, 2014; Rapsikevicius *et al*., 2021). Among these, we can mention more efficient use of energy resources, which leads to less emission of pollution. However, in the meantime, the importance of the general aspect of the environment and the external effects of production should not be neglected, and the importance of transparent environmental regulations should also be taken into consideration (Carlsson and Lundström, 2002).

The second chanel mentioned for the impact of economic freedom on the environment is the structure of property rights. In fact, in a free economic environment, the security of capital is provided, and property rights are recognized, so long-run investments like environmental investments increase because usually they are profitable in the long run. Therefore, the quality of the environment improves. Norton (1998) clearly shows the positive effect of property rights on the quality of the environment (Norton, 1998). In addition to the mentioned classical paths, a new path for the effect of economic freedom on the quality of the environment has recently been noticed in economic literature. It is stated that in a free economic and competitive environment, economic enterprises are looking for production methods with the lowest cost and the highest profitability and are constantly innovating for the optimal use of resources. This improvement in productivity leads to more efficient use of resources and reduces the pressure on the environment. While in the first path, the efficiency of the markets and the optimal use of resources are emphasized, this new path is based on the motivation of economic enterprises to increase efficiency according to recent developments in environmentally friendly technologies. In addition, in the recent decades, green and environmentally friendly technologies have grown significantly, which can lead to a higher quality of the environment (Berggren and Bjørnskov, 2021; Bjørnskov, 2020).

Some empirical studies also confirm the relationship between economic freedom and environmental quality. For example, Chang &

Wang (2012) investigated the effect of economic freedom and income on CO_2 emission using panel data approach and concluded that increasing freedoms (monetary freedom, trade freedom and financial freedom) after a certain level of income, decreases environmental pollution (Chang and Wang, 2012). Wood and Herzog (2014) also investigated the relationship between economic freedom and air quality and show that although this relationship is positive in the long run, in the short-run economic freedom may also have a negative effect on CO_2 emission (Wood and Herzog, 2014). Adesina and Mwamba (2019) using a panel model for 24 African countries during 1996 to 2013, show that increasing economic freedom (with sub-indices of trade freedom, business freedom, and financial freedom) increases the quality of the environment (Adesina and Mwamba, 2019). Babaki and Eliaspour (2021) also examined the relationship between economic freedom and CO_2 emissions in OPEC countries during 1996-2014 and concludes that economic freedom has a positive effect on the quality of the environment and reducing CO_2 emissions (Babaki and Eliaspour, 2021). One of the latest research projects in this field is the study of Rapsikevicius *et al*. (2021) about the impact of economic freedom on environmental quality in European countries. This research also confirms the complexity of the results in this field and the different effects of economic freedom on the quality of the environment. They propose an optimal level of economic freedom up to which the effects of freedom on the environment quality are positive (Rapsikevicius *et al*., 2021).

Political freedoms and the quality of governance have also been addressed by empirical works as driving force of environmental quality. Political and social freedoms and governance quality affect the environment through several channels, some of which are positive while others may affect adversely, and its final effect must be tested in different regions and times.

The first path for the positive effect of political freedom on the quality of the environment was proposed by some researchers such as Schultz and Crockett (1990) and Payne (1995), who consider freedom of information and political rights to increase awareness, especially environmental awareness, and this in turn leads to better environmental laws. Indeed, the free flow of information facilitated by political and social freedom plays a crucial role in increasing public awareness of environmental issues. Additionally, political freedom empowers citizens to choose their government representatives, who are responsible for addressing environmental concerns and responding to public sensitivities in this regard. In countries without political freedoms, information dissemination is often censored, making it difficult for information about environmental degradation to reach the community level. Furthermore, the absence of accountability and responsibility on the part of authorities in such environments regarding environmental destruction leaves citizens with limited power to effect change. They are unable to influence policies and procedures related to environmental preservation, as their ability to alter the situation is constrained (Schultz and Crockett, 1990; Payne, 1995). Also, in a free and democratic government, in terms of the rule of law, the authorities are forced to follow environmental laws and implement them, while in dictatorial countries, legal requirements are usually not met (Weiss and Jacobsen, 1999; Gleditsch and Bjorn, 2003).

In addition, in some studies, such as Congleton (1992), other paths are also mentioned for the impact of political freedom on the environment. He states that in the absence of political freedoms and with dictatorial governments, leaders show strong resistance to maintaining their systems and therefore may use many resources even inefficiently to put pressure on the people not to change their systems. In such cases, environmental laws are usually ignored (Congleton, 1992).

However, in contrast to the mentioned studies, there are also other studies that show that democracy not only does not lead to the improvement of the environmental quality but

may also accelerate the process of its destruction. For example, since the environment is a public good, when there are political freedoms, people may ignore the environment and put excessive use of resources on their agenda (Hardin, 1968). It is also stated that in democratic systems with political freedom, the financing of elections is usually done by capitalists who seek to maximize their profits as quickly as possible and due to the slow return of environmental investments, the environment and related laws usually are not prioritized. On the other hand, in free and democratic political systems, the priority of the governments is the concerns of the voters and when the livelihood level of the people in the society is not at an acceptable level, the economic needs are given a higher priority than the environment quality and therefore the quality of environment may even decrease (Jafariparvizkhanlou, 2020).

To empirically examine the above theories, several studies have been conducted, some of the most important of which are mentioned below. Li and Reuveny (2006) investigated the relationship between democracy and environmental degradation in 143 countries during 1961-1997 using the panel data method. They show that democracy has a negative effect on the processes of destruction of environmental indicators such as carbon dioxide emission, nitrogen dioxide emission, deforestation, land destruction and water pollution, and the increase of democracy leads to the improvement of the environment and its indicators (Li and Reuveny, 2006). Also, Bernauer and Koubi (2009) in the research titled "effects of political institutions on air quality" by examining 107 cities from 42 countries with the panel data method, concluded that democracy has a direct effect on air quality and government size plays the most important role (Bernauer and Koubi, 2009). Callejas (2010) also used panel data approach to investigate the relationship between democracy and CO2 emissions among Latin American countries and concluded that improving the state of democracy and expanding economic freedoms leads to improving the quality of the environment (Callejas, 2010).

Farzanegan and Markwardt (2012) also studied MENA countries using panel data method and concluded that the improvement of democratic conditions and the increase of political freedoms led to the improvement of the quality of the environment in these countries and freer institutions have had the greatest impact on its improvement (Farzanegan and Markwardt, 2012). Joshi and Beck (2018) show the impact of political and economic freedoms on the environment by dividing countries into developed (OECD) and underdeveloped (non-OECD). They conclude that none of the kinds of political freedoms affect CO_2 emissions (Joshi and Beck, 2018). In fact, as can be seen here, despite the fact that most studies show a positive relationship between political freedom and the quality of the environment, this relationship is not determined and requires more studies in different times and places.

Another type of freedom that affects environmental quality is trade freedom. It can also affect the quality of the environment in different aspects and ways, which are mentioned in the economic literature and are briefly discussed here.

One of the first channels discussed for the impact of trade freedom on the environment is the displacement hypothesis. According to this hypothesis, international free trade in terms of goods and capital causes the transfer of polluting industries from countries with restricting environmental laws to countries with weaker environmental laws. In fact, when a developing country becomes freer in terms of trade, the more pollution it will suffer as environmental policies become stricter in developed countries (Copeland and Taylor, 1995; Dinda, 2004; Harrison, 1996). The pollution haven hypothesis is also modeled by Copeland and Taylor (1994) in the same direction. This hypothesis states that weak environmental laws are the cause of comparative advantage for developing countries and multinational companies that produce environmentally polluting goods tend

to move the factories that produce these goods to developing countries with weak environmental laws. Obviously, this reduces the quality of the environment in developing countries with low per capita income (Copeland and Taylor, 1995; Dinda, 2004).

Here, another path that affects environmental quality is the race to the bottom. Based on this, relatively stricter laws in developed countries increase the relative costs of production in these countries compared to developing countries. Therefore, at least a few producers of polluting industries in developed countries have found the motivation to relocate and the transfer of capital abroad increases. The result of this is the motivation of the government to reduce environmental standards and reduce the quality of the environment (Mani and Wheeler, 1998).

Along with these paths, which have almost a contradictory effect (improving the quality of the environment in developed and high-income countries and reducing the quality of the environment in developing countries), there are also channels for the positive impact of free trade on the quality of the environment. For example, the diffusion of technology theory states that the diffusion of knowledge and the transfer of technology resulting from free trade can affect the quality of the environment in two ways. First, with the advancement of technology and its transfer, the production processes of goods will require smaller amounts of environmental inputs and less pollution will be released. Secondly, improving technology will lead to increased efficiency, productivity, waste recycling and reducing pollutants, which means a cleaner environment (Reppelin-Hill, 1999). As a summary of the role of trade freedom, it can be stated that there are generally two views in this field. The first view states that free trade can deteriorate the quality of the environment in various ways such as increasing the size of the economy, increasing the production of polluting goods and export-oriented policies that destroy resources (Adkins and Garbaccio, 2007; Lee and Roland-Holst, 1997). The second view believes that trade freedom through effects such as the diffusion of technology and more efficient use of resources lead to the improvement of the environment quality (Dinda, 2009; Antweiler *et al*., 2001). In addition to freedom and its sub-indices, other important variables such as per capita income and the human development index (HDI) also affect the quality of the environment which have been mentioned in the related literature (Stern, 2018; Pourali *et al.*, 2019; Zhang and Zhijie, 2022; Magnani, 2000; Bjørnskov, 2020).

The most important factor that has been examined in several studies is per capita income. This issue is discussed in the form of the inverted U curve or the Kuznets environmental curve. According to this theory, in the early stages of growth and low per capita incomes, priority is given to the process of industrialization and more production and employment, and low technology and not giving priority to the environment causes economic enterprises to be unable and unwilling to protect the environment. In this scenario, as per capita income increases, there is often a negative impact on environmental quality initially. However, in the subsequent stages of economic growth and further increases in per capita income, the environment begins to garner more attention and importance. At this stage, technological advancements tend to expand, environmental regulations become more stringent, and the awareness and sensitivity of society's citizens toward environmental issues increase. Consequently, economic growth and higher per capita income levels are associated with improvements in environmental quality. In recent years, numerous empirical studies have explored this subject using various approaches, shedding light on the complex relationship between economic development, income levels, and environmental outcomes (Filimonova *et al.*, 2020; Lotfalipour *et al.*, 2010; Shahabadi *et al*., 2017; Magnani, 2000; Bjørnskov, 2020; Dinda, 2004; Stern, 2018). In addition to GDP per capita, other indicators such as HDI, energy intensity, Percentage of people in the large cities, arable lands and agriculture, forestry and fishing value added are also considered as

control variables in the modeling framework. Increasing the level of education and life expectancy and as a result HDI has increased people's awareness and desire to live longer, which will also have a positive impact on the quality of the environment (Pourali *et al*., 2019; Zhang and Zhijie, 2022). But besides the theoretical justifications of each variable, the most important reason for using these variables is the positive correlation of these variables with the environmental performance index, and it is emphasized in the 2022 EPI report as well (Wolf *et al*., 2022).

Model

Study Design

In this study, the applied data relates to countries in the Middle East and North Africa region with Turkey (MENAT) include: (Algeria, Bahrain, Egypt, Iran, Jordan, Kuwait, Lebanon, Morocco, Oman, Qatar, Saudi Arabia, Tunisia, United Arab Emirates and Turkey) during 2000 to 2021 have been extracted through the relevant time series data. There are no complete data series in other countries of the region (such as Syria, Iraq, Palestine, Sudan, and Yemen). The environmental performance index data is extracted from the EPI website, which was prepared by the EPI research team at Yale University and Columbia University; The data of economic, political, and commercial freedoms were extracted from the website of the Heritage Foundation and the data of other variables were extracted from the website of the World Bank.

Based on theoretical foundations, the estimated model is as equation (1):

$$EPI = f(EF, TF, PF, GDP, GDP^2, Arableland, PLC, Exportindex, Agrivalue, Energy, HDI) \quad (1)$$

The independent variables include economic freedom (EF), trade freedom (TF), and political freedom (PF) and control variables include GDP per capita (constant 2015 in thousand dollars), arable land (% of land area), Percentage of people in the large cities (PLC), Export value index[1] (2015= 100), Agriculture, forestry and fishing value added (constant 2015 in billion dollars), Energy intensity (Energy) and human development index (HDI).

The environmental performance index (EPI) as a dependent variable is prepared based on various data and information. EPI is composed of two components, ecosystem vitality and environmental health, both of which comprise several sub-indexes. These indicators show the situation of different countries between 0 and 100 from the worst to the best. Table 1 shows the share of each of the mentioned indicators in the main EPI index.

Table 1- Environmental Performance Index

Ecosystem Vitality	0.6	Environmental Health	0.4
Climate Change	0.24	Air Quality	0.2
Biodiversity & Habitat	0.15	Sanitation & Drinking Water	0.16
Ecosystem Services	0.06	Lead exposure	0.02
Fisheries	0.06	Controlled solid waste	0.02
Pollution Emissions	0.03		
Agriculture	0.03		
Water Resources	0.03		

Source: EPI website

According to the Heritage Foundation report in 2020, Economic freedom based on 12 quantitative and qualitative factors that they are grouped into four broad categories, or pillars, of economic freedom:

1. Rule of Law (property rights,

1- Export values are the current value of exports (f.o.b.) converted to U.S. dollars and expressed as a percentage of the average for the base period 2015.

government integrity, and judicial effectiveness)

2. Government Size (government spending, tax burden, fiscal health)

3. Regulatory Efficiency (business freedom, labor freedom, monetary freedom)

4. Open Markets (commercial freedom, investment freedom, financial freedom)

Each of the twelve economic freedoms within these categories is graded on a scale of 0 to 100. A country's overall score is derived by averaging these twelve economic freedoms, with equal weight being given to each.

Political freedom is based on two qualitative factors: PR stands for political rights, CL stands for civil liberties, and Status refers to freedom status. PR and CL are measured on a one-to-seven scale, with one representing the highest degree of Freedom and seven the low. (Heritage Foundation 2020).

Data Collection

The descriptive characteristics of the series of environmental factors are shown in Table 2. In the case panel: the climate change index has improved since 2010 in most countries, while it has decreased in previous years; The index's mean is the least in Oman (14.4) and the greatest in Tunisia (44.3); for Iran, it stands at 34.1. The index's mean is the least in Morocco and Egypt (10.5), while the highest values are observed in the UAE, Qatar, and Kuwait (21.7); for Iran, it stands at 16.1. The mean ecosystem vitality index has remained stable, with no significant changes observed. Notably, this index's mean value is lowest in Oman (12.6), while the highest mean values are observed in Saudi Arabia and Egypt (22.4); for Iran, the mean stands at 20.6. And finally, the EPI is increasing with a gentle slope; the lowest mean is related to Morocco (27.1) and the highest to Kuwait and UAE (40.5); and about Iran (36.7). In general, the means and medians of these factors are less than 50 and thus in this region has not had a good situation in terms of environmental indicators. Also, the factor of climate change has the highest level of dispersion. The discrepancy can be attributed to the fact that some countries in the region export oil and gas, while others do not.

Table 2- Descriptive statistics of the Environmental factors

	Climate Change	Ecosystem Vitality	Environmental Health	EPI
Mean	31.33	30.95	43.14	35.83
Median	30.93	30.49	43.67	36.11
Maximum	59.08	49.52	59.12	52.39
Minimum	6.34	16.40	19.99	23.60
Std. Dev.	11.21	6.69	9.56	5.50

Source: research findings

The descriptive characteristics of the series of freedom factors are shown in Table 3. In the case panel: The index of economic freedom of countries has changed in a limited range; the lowest mean of this index is related to Iran (44.1) and the highest to Bahrain and UAE (72). With the exception of Iran, Morocco, and Tunisia, the trade freedom index experiences minor fluctuations. Iran's trade freedom index has decreased since 2005. The mean value of this index is observed to be the least in Tunisia and Iran (54.5), whereas the highest mean value is noted in Turkey and UAE (80.5). A lower political freedom index indicates that the state of political freedom is better in countries. According to the mean of this index, the political freedom situation of Turkey (3.9) is relatively good and the situation of Saudi Arabia (6.9) is not good. And the mean of political freedom index in Iran is (6).

In general, the means and medians of factors trade and economic freedom are more than 50 and for political freedom are more than 3.5. Therefore, economic freedom almost exists in these countries, but political freedom is limited. Also, trade freedom is more dispersed than economic freedom.

Table 3- Descriptive statistics of the Freedom factors

	Trade freedom	Economic freedom	Political freedom
Mean	71.01	61.46	5.29
Median	75.80	62.20	5.50
Maximum	86.60	77.70	7.00
Minimum	27.20	35.90	2.00
Std. Dev.	12.85	8.22	0.97

Source: research findings

Methods

In general, panel data models can be estimated using three different methods: (a) with a common constant; (b) allowing for fixed effects; and (c) allowing for random effects (Asteriou and Hall, 2021).

The common constant method (also called the pooled OLS method) of estimation presents results under the principal assumption that there are no differences among the data matrices of the cross-sectional dimension (*N*). In other words, the model estimates a common constant *a* for all cross-sections (common constant for countries).

$$Y_{it} = \alpha + \beta X_{it} + u_{it} \quad (2)$$

In the fixed effects method the constant is treated as group (section)-specific. This means that the model allows for different constants for each group (section). Thus, the model is similar to that in Equation (3):

$$Y_{it} = \alpha_i + \beta X_{it} + u_{it} \quad (3)$$

The fixed effects estimator is also known as the least squares dummy variable (LSDV) estimator because, to allow for different constants for each group, it includes a dummy variable for each group. Where the dummy variable is the one that allows us to take different group-specific estimates for each of the constants for each different section. To do this, the standard *F*-test can be used to check fixed effects against the simple common constant OLS method. The null hypothesis is that all the constants are the same (homogeneity), and that therefore the common constant method is applicable:

$$H_O:\ \alpha_1 = \alpha_2 = \cdots = \alpha_N \quad (4)$$

The *F*-statistic is:

$$F = \frac{(R_{FE}^2 - R_{CC}^2)/(N-1)}{(1-R_{FE}^2)/(NT-N-K)} \sim F(N-1, NT-N-k) \quad (5)$$

where R_{FE}^2 is the coefficient of determination of the fixed effects model and R_{CC}^2 is the coefficient of determination of the common constant model. If *F*-statistical is greater than *F*-critical we reject the null hypothesis.

An alternative method of estimating a model is the random effects model. The difference between the fixed effects and the random effects method is that the latter handles the constants for each section not as fixed but as random parameters. Hence the variability of the constant for each section comes from:

$$\alpha_i = \alpha + \vartheta_i \quad (6)$$

Where v_i is a zero mean standard random variable.

The random effects model therefore takes the following form:

$$Y_{it} = (\alpha + v_i) + \beta_1 X_{1it} + \beta_2 X_{2it} + \cdots + \beta_k X_{kit} + u_{it}\text{b} \quad (7)$$

$$Y_{it} = \alpha + \beta_1 X_{1it} + \beta_2 X_{2it} + \cdots + \beta_k X_{kit} + (v_i + u_{it})$$

The Hausman test is formulated to assist in making a choice between the fixed effects and random effects approaches. Hausman (1978) adapted a test based on the idea that under the hypothesis of no correlation, both OLS and GLS are consistent, but OLS is inefficient, while under the alternative OLS is consistent but GLS is not. More specifically, Hausman assumed that there are two estimators $\hat{\beta}_0$ and $\hat{\beta}_1$ of the parameter vector $\boldsymbol{\beta}$ and he added two hypothesis-testing procedures. Under H_O, both estimators are consistent but $\hat{\beta}_0$ is inefficient, and under H_a, $\hat{\beta}_0$ is consistent and efficient, but $\hat{\beta}_1$ is inconsistent. The Hausman test uses the following test statistic:

$$H = \left(\hat{\beta}^{FE} - \hat{\beta}^{RE}\right)' \left[var\left(\hat{\beta}^{FE}\right) - var\left(\hat{\beta}^{RE}\right)\right]^{-1} \left(\hat{\beta}^{FE} - \hat{\beta}^{RE}\right) \sim \chi^2(k) \quad (8)$$

If the value of the statistic is large, then the difference between the estimates is significant, so we reject the null hypothesis that the random effects model is consistent and use the fixed effects estimator. In contrast, a small value for the Hausman statistic implies that the random effects estimator is more appropriate.

Results and Discussion

Before estimating the effects of explanatory variables on dependent variable, some tests are necessary. First, to avoid any spurious regression problems, the Levin–Lin–Chu test is used for the stationary status of the variables. In Table 4, the results of Levin–Lin–Chu stationary tests for all variables are reported.

Table 4- The results of the Levin-Lin-Chu stationary test of variables

EPI	-3.84617	HDI	-3.95767
Climate Change	-2.94746	GDP per capita	-2.31476
Ecosystem Vitality	-2.77643	Energy intensity	-2.14671
Environmental Health	-6.92879	Export index	-1.40807
Trade freedom	-3.24249	Arable land	-1.67169
Economic freedom	-3.64791	Agriculture value added	-1.94055
Political freedom	-3.20266	People in the large cities	-6.81148

Source: research findings

The null hypothesis in the Levin–Lin–Chu test is that all panels (each time series) contain a unit root. According to the results of Table 2, all variables are stationary. Another important test is the collinearity test, which should not exist between explanatory variables. The results of the correlation between explanatory variables are reported in Table 5; it shows that there is no strong correlation between the explanatory variables and therefore there is no collinearity problem.

Table 5- Partial correlation between explanatory variables

EF	1.000									
TF	0.552	1.000								
PF	0.089	-0.055	1.000							
GDPPER	0.454	0.339	0.151	1.000						
ARABLELAND	-0.342	-0.208	-0.568	-0.368	1.000					
ENERGY	0.097	0.051	0.376	0.269	-0.466	1.000				
EXPORTINDEX	0.006	0.288	0.053	0.065	-0.103	0.120	1.000			
AGRIVALUE	-0.491	-0.127	-0.038	-0.333	0.504	-0.175	0.052	1.000		
PLC	0.264	0.287	-0.123	0.226	-0.282	0.072	-0.007	-0.296	1.000	
HDI	0.478	0.578	0.324	0.520	-0.441	0.471	0.335	-0.157	0.283	1.000

Source: research findings

Then, in order to determine the pool or panel regression model, first the model is estimated by assuming fixed effects for the cross-section and then by assuming random effects. The F and λ^2 statistics for the cross-sectional fixed effects test are reported in Table 6; the p-values of these statistics are less than 0.05, and therefore the null hypothesis is rejected, which means that there are cross-sectional fixed effects. Furthermore, the null hypothesis favoring random effects is rejected when considering the λ^2 statistic derived from the Hausman test. Consequently, the results of these tests indicate a preference for the fixed effects model over the random effects model.

Table 6- fixed and random effects test for the cross section

Model:	Effects Test	Statistic	d.f	Prob
Model(1)	Cross-section F	27.620	(13,283)	0.0000
dependent variable:	Cross-section Chi-square	252.329	13	0.0000
EPI	Cross-section random	75.206	11	0.0000
Model(2)	Cross-section F	25.910	(13,283)	0.0000
dependent variable:	Cross-section Chi-square	241.477	13	0.0000
Ecosystem Vitality	Cross-section random	80.212	11	0.0000
Model(3)	Cross-section F	114.348	(13,283)	0.0000
dependent variable:	Cross-section Chi-square	564.571	13	0.0000
Environmental Health	Cross-section random	58.187	11	0.0000
Model(4)	Cross-section F	12.539	(13,283)	0.0000
dependent variable:	Cross-section Chi-square	140.112	13	0.0000
Climate Change	Cross-section random	26.225	11	0.0060

Source: research findings

The heteroskedasticity and autocorrelation tests for cross-sections are two other important pretests that results are reported in Table 7. The null hypothesis of homoskedastic residuals is rejected and so the weighted least squares method is used to estimate the model. Also, null hypothesis for no cross-sectional dependence in residuals has been accepted.

Table 7- Heteroskedasticity and autocorrelation tests

Effects Test	Test	Statistic	Prob
(1) dependent variable: EPI	LR	102.469	0.0000
	Pesaran CD	1.383	0.1715
(2) dependent variable: Ecosystem Vitality	LR	125.317	0.0000
	Pesaran CD	1.215	0.2241
(3) dependent variable: Environmental Health	LR	256.134	0.0000
	Pesaran CD	-0.020	0.983
(4) dependent variable: Climate Change	LR	69.363	0.0000
	Pesaran CD	0.220	0.825

Source: research findings

In the literature review, the relationship between the environmental performance index (EPI) with economic freedom, trade freedom and political freedom was explained theoretically. In this section, the relationships between these variables are estimated empirically using the panel EGLS (Cross-section weights) method (Table 8).

Table 8- The relationship between freedom indices and EPI

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-16.79234	5.614745	-2.990757	0.0030
EF	0.076646	0.036299	2.111515	0.0356
TF	-0.012537	0.015937	-0.786669	0.4321
PF	-1.155912	0.240977	-4.796764	0.0000
GDPPER	-1.207823	0.182860	-6.605189	0.0000
GDPPER^2	0.009673	0.001761	5.493442	0.0000
ARABLELAND	1.421587	0.201828	7.043576	0.0000
ENERGY	-1.190653	0.182257	-6.532815	0.0000
EXPORTINDEX	-0.004576	0.004597	-0.995505	0.3203
AGRIVALUE	0.234323	0.043451	5.392817	0.0000
PLC	-0.117141	0.040479	-2.893843	0.0041
HDI	79.02078	5.922493	13.34249	0.0000
R-squared	0.876191	Mean dependent var		40.21629
Adjusted R-squared	0.865692	S.D. dependent var		11.80128
S.E. of regression	2.529768	Sum squared resid		1811.122
F-statistic	83.44944	Durbin-Watson stat		1.395140
Prob(F-statistic)	0.000000			

Source: research findings

The results of Table 8 show that the effect of variables EF, PF, HDI, GDPPER, $GDPPER^2$, ARABLELAND, ENERGY, AGRIVALUE, PLC, HDI are significant; versus TF and EXPORTINDEX are not significant. Furthermore, there is a negative relationship between PF and EPI. However increasing the amount PF means that the level of political freedom decreases. Therefore, there is a positive relationship between the level of political freedom and the environmental performance index. The positive effect of political freedom on environment quality was mentioned in other studies such as Schultz and Crockett (1990), Payne (1995), Bernauer and Koubi (2009), Callejas (2010) and Farzanegan and Markwardt (2018). They believe that information transparency and political rights increase people's environmental awareness and lead to the creation of strong laws to protect the environment. On the other hand, in a free society, legislators are forced to obey environmental laws and implement them. While in non-free societies, public interests are usually not considered (Weiss and Jacobsen, 1999), (Gleditsch and Bojren, 2003).

Also, according to Table 8, there is a positive and significant relationship between economic freedom and EPI. The existence of this relationship confirms that economic freedom leads to the creation of more efficient and competitive markets and the efficient allocation of resources, especially energy. Therefore, the quality of the environment increases with more economic freedom (Bjørnskov, 2020; Bernauer and Koubi, 2013; Carlsson and Lundström, 2002, Carlsson and Lundström, 2003).

The results of the test show that the GDPPER coefficient is positive, but the $GDPPER^2$ coefficient is negative. This means that the relationship between GDPPER and EPI is nonlinear and concave up; So that first the relationship between two variables is negative and then this relationship becomes positive. In other words, in the early stages of economic growth and development, governments destroy the country's environment by putting pressure on resources; And after achieving a high level of GDP per capita, they are forced to protect the environment under the pressure of the people, so EPI improves. This behavior of people is reminiscent of Maslow's Hierarchy of Needs theory. Arableland, Agrivalue and HDI have positive and significant effects on EPI; The percentage of arable land and the added value of the agricultural sector can be considered as indicators of the greenness of a country, and the increase of these indicators leads to more vitality of the environment and more EPI; Also, HDI's analysis says that increasing the level of education and life expectancy increases people's awareness and their desire to live longer and as a result increases EPI. In other words, the development process leads to an increase in EPI. ENERGY and PLC variables have a negative and significant effect on EPI. That means, the high percentage of urbanization and high intensity of energy consumption destroy the environment and reduces EPA. Considering that the EPI consists of two sub-indices of ecosystem vitality and environmental health, it seems to be useful to examine the effect of different variables on these two sub-indices of EPI. The findings are shown in Table 9.

Table 9- The relationship between freedom indicators with the two main parts of the EPI

	Ecosystem Vitality			environmental health		
Variable	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.
C	-17.33364	-2.020353	0.0443	-10.04794	-3.187619	0.0016
EF	-0.174396	-2.970772	0.0032	0.118307	5.280003	0.0000
TF	-0.030553	-1.379472	0.1688	0.027774	2.367326	0.0186
PF	-1.442733	-4.233040	0.0000	-0.464451	-2.969286	0.0032
GDPPER	-1.695221	-6.022341	0.0000	-0.765578	-8.642286	0.0000
GDPPER^2	0.012905	4.823034	0.0000	0.007271	8.002754	0.0000
ARABLELAND	1.783956	6.136939	0.0000	0.575283	3.954426	0.0001
ENERGY	-1.925284	-6.464283	0.0000	-0.130763	-1.409455	0.1598
EXPORTINDEX	-0.015763	-2.154678	0.0320	0.013688	5.734019	0.0000
AGRIVALUE	0.192201	2.750032	0.0063	0.335222	10.77642	0.0000
PLC	-0.152546	-2.323312	0.0209	0.034005	1.487019	0.1381
HDI	79.99291	9.030053	0.0000	78.70543	22.66482	0.0000
	R-squared		0.768181	R-squared		0.981429
	Adjusted R-squared		0.748521	Adjusted R-squared		0.979854
	F-statistic		39.07406	F-statistic		623.1675
	Prob(F-statistic)		0.000000	Prob(F-statistic)		0.000000
	Durbin-Watson stat		1.398999	Durbin-Watson stat		1.166517

Source: research findings

Comparing the coefficients of the variables in Tables 8 and 9 shows that the impact of PF, GDPPER, Arableland, Agrivalue and HDI variables on environmental health, ecosystem vitality and EPI Indicators are the same. However, there are some differences in other cases.

Political freedom has a positive and significant effect on both EPI and the ecosystem vitality index, but its effect on the index of environmental health is insignificant. Legal and social pressures for environmental protection increase in society with political freedom and it leads to improvement of the EPI and environmental vitality index, but the per capita income index is more important in improving the environmental health index. In some countries of the MENA region, such as the UAE, Saudi Arabia, and Qatar, which have high per capita income and low democracy, the environmental health index has a favorable situation.

Economic freedom index have a positive effect on the environmental health index, but it has a negative effect on the ecosystem vitality index. It seems that the economic growth resulting from economic freedom leads to the improvement of the health status of the society and the increase of the environmental health index; On the other hand, economic growth in the initial stages requires more use of natural resources; Over-harvesting of resources destroys the environment and reduces the vitality ecosystem index.

Trade freedom has a positive relationship with the environmental health index, but it has no significant relationship with the ecosystem vitality index. It is interpreted that trade freedom improves the living conditions and the health status of the society, but the effect of trade freedom on the vitality index of the ecosystem is neutralized by the mutual effects of export and import. In order to increase exports, resources are used inappropriately, and on the other hand, imports lead to the optimal allocation of resources, and it reduces the country's need to produce items that do not have an advantage.

Also, the findings of Table 9 show that percent of the population in the largest cities and energy intensity have a contradictory effect on the EPI; So that Increasing urbanization and energy availability improve environmental health (such as Access to comfort facilities and equipment, safe drinking water and municipal sewage system), But instead they disturb the ecosystem.

Climate change index is another important component of the EPI. In recent decades, the trend of climate change and the destructive consequences of this phenomenon on the planet has increased significantly. This incident has

led to the issue of climate change becoming an important concern for human society. The effect of explanatory variables on climate change index is reported in Table 10.

Table 10- The relationship between freedom indices and climate change

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-85.41610	14.99948	-5.694604	0.0000
EF	-0.273672	0.111626	-2.451686	0.0148
TF	-0.024835	0.041797	-0.594193	0.5529
PF	-2.619629	0.729369	-3.591639	0.0004
GDPPER	-1.428173	0.442175	-3.229882	0.0014
GDPPER^2	0.012296	0.004529	2.715083	0.0070
ARABLELAND	3.345552	0.562087	5.952022	0.0000
ENERGY	-1.660298	0.515555	-3.220408	0.0014
EXPORTINDEX	-0.073566	0.013106	-5.613338	0.0000
AGRIVALUE	0.274953	0.136838	2.009340	0.0455
PLC	-0.702250	0.127117	-5.524436	0.0000
HDI	131.8315	15.86835	8.307829	0.0000
R-squared	0.680745	Mean dependent var		36.43914
Adjusted R-squared	0.653670	S.D. dependent var		18.00642
S.E. of regression	7.566972	Sum squared resid		16204.32
F-statistic	25.14325	Durbin-Watson stat		1.375525
Prob(F-statistic)	0.000000			

Source: research findings

The findings show that the variables of political freedom, Arable land, Agrivalue and HDI have a positive and significant effect on climate change index. These findings are compatible with the studies of Callejas (2010), Rana Alaa *et al*. (2017), Filimonova *et al*. (2020) and Babaki and Elyaspour (2021). These relations are interpreted as follows: Increasing awareness, transparency, rule of law in society (through political freedom) reduces the negative external consequences of greenhouse gas emissions. The percentage of arable land and the agriculture value added are indicators for the greenness and mildness of the climate, which lead to the improvement of the quality of the climate. HDI index, education increases people's awareness and attention to health and the environment, and therefore they put pressure on the government to create laws and regulations to protect the environment. And finally in developed countries with high HDI, society is more sensitive to climate quality and therefore the pressure of public opinion leads to the prevention of high emissions of greenhouse gases. According to the model coefficients showed in Table 10, there is a negative and significant relationship between FE, GDP per capita, Energy intensity, Export index and PLC with climate change. These relationships can be interpreted as follows: Economic freedom tends to boost domestic production and attract foreign direct investment (FDI), thereby promoting economic development. However, in the specific context of this study area, FDI predominantly occurs in the oil and petrochemical industries. As a result, one negative consequence of this economic activity is an increase in air pollution and greenhouse gas emissions. Moreover, in line with the earlier discussion, the process of industrialization in developing countries often yields a paradoxical effect. This means that the shift from traditional production methods to modern ones leads to an increase in GDP per capita, urbanization, exports, and energy consumption. However, it also places significant pressure on natural resources, contributes to environmental degradation, and results in higher emissions of pollutants.

Conclusion

According to the theory, political, economic and commercial freedoms are factors affecting the environmental performance index (EPI). In this study, the relationships between variables were experimentally tested using data from 14 countries in the MENAT region during the years 2000-2020. To control other influencing

variables, variables of GDP per capita, Human Development Index, urban population ratio, export ratio, value added ratio of agricultural sector and energy intensity were entered into the model. And the final model was estimated by panel data method.

The results of the estimations show that political freedom has a positive and significant effect on EPI, ecosystem vitality and climate change index. However political freedom does not have a significant effect on the environmental health index. Therefore, the existence of political freedom in society causes the awareness and action of the society against the destruction of the environment, and it also increases the efficiency of environmental policies and regulations, and ultimately improves the quality of the environment and reduces pollution. In general, the existence of democracy leads to good governance, which can lead to the protection, maintenance, and preservation of the environment as a public good. However political freedom has no significant effect on improving environmental health. In this case, GDP per capita growth is a more important factor in improving health infrastructure such as safe drinking water and sewage system.

Moreover, the estimation results show that economic freedom has a positive and significant effect on EPI and environmental health index; and it has a negative and significant effect on the ecosystem vitality index and climate change index. Economic freedom leads to the development of businesses and GDP per capita growth, and according to Kuznets' theory, it improves the EPI and the environmental health index. However more economic growth due to the improvement of the business environment in competitive conditions may increase the use of resources significantly. Although it is expected that by creating a competitive environment, the consumption of resources especially energy, will be saved and used efficiently, but this does not happen because energy (through subsidies) is provided at prices much lower than the global prices in most countries of this region. Therefore, the necessity of saving and efficient allocation of fossil fuels is not felt less by consumers and producers. Also, economic freedom facilitates investment platforms for foreign investors, thus increasing foreign direct investment (FDI) in the country. However foreign investment is mostly done in the oil and gas sector and related industries because there are abundant reserves of oil and gas in MENA countries and ultimately through the creation of effluents and emissions of gases lead to water, soil and air pollution. Therefore, they degrade the indicators of ecosystem vitality and climate change. It seems that economic freedom has an improving effect on the previous indicators in developed countries through more efficient allocation of resources.

The study's findings indicate that there is no significant relationship between trade freedom and the Environmental Performance Index (EPI), ecosystem vitality, or climate change. However, a positive and significant relationship exists between trade freedom and the Environmental Health Index. From a theoretical standpoint, trade freedom is associated with several positive effects. It can lead to improved allocation of domestic resources, facilitate technology transfer, and promote the transition from older, polluting industries to cleaner ones. Consequently, this can contribute to an overall enhancement in environmental quality. However, it's worth noting that some argue that trade freedom might lead to the relocation of polluting industries from wealthier countries to host countries, potentially resulting in environmental harm to the latter. The statistical findings of this study suggest that trade freedom in MENA countries has not had a detrimental impact on the environment. It's important to consider that many countries in this region are both oil exporters and importers of various goods, and the level of foreign investment in their industrial sectors tends to be relatively low. Therefore, positive, and negative external consequences do not strongly affect the environment. But on the other hand, trade liberalization has improved the living conditions in these countries and therefore had a positive effect on the environmental health

index. Also, the findings show that some control variables have a significant effect on dependent variables. In particular, the theoretical relationship and causality between HDI and EPI have been investigated in several experimental studies. The findings of this study are consistent with the results of previous studies and confirm most of the results of previous studies. So that HDI has a positive and significant effect on EPI as well as on its parts (ecosystem vitality, environmental health and climate change). In contrast, the GDP per capita effect is not the same between different studies. It means that per capita GDP per capita has not had a significant effect on EPI and the vitality of the ecosystem, while it has a positive effect on environmental health and a negative effect on climate change. This situation is explained by the U-shaped effect of the Kuznets theory. In MENA countries (as developing countries), climate change is in the downward part of the curve and environmental health is in the upward part of the curve, and in this regard, EPI and ecosystem vitality are in the lower part of the U curve. Finally, the two variables of energy intensity and the ratio of exports to GDP per capita have a negative effect on the EPI and its parts (ecosystem vitality, environmental health, and climate change). This result is logical and compatible with theoretical foundations.

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Journal of Agricultural Economics & Development

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مقاله پژوهشی

جلد ۳۷ شماره ۲، تابستان ۱۴۰۲، ص. ۱۷۶-۱۵۷

آزادی و عملکرد زیست محیطی: شواهد از کشورهای MENAT

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تاریخ دریافت: ۱۴۰۲/۰۲/۱۵

تاریخ بازنگری۱۴۰۲/۰۴/۲۴

تاریخ پذیرش: ۱۴۰۲/۰۴/۲۶

چکیده

کیفیت محیطزیست و عوامل تعیین کننده آن یکی از چالش‌های اصلی حال و آینده بشریت است و توسعه پایدار در راستای حفظ و بهبود محیطزیست تفسیر می‌شود. در سال‌های اخیر مطالعات زیادی در مورد عوامل موثر بر کیفیت محیطی انجام شده است. یکی از موضوعات اصلی که در مطالعات مرتبط کمتر مورد توجه قرار گرفته است، تأثیر حاکمیت بر کیفیت محیطزیست است. در این مطالعه تأثیر مؤلفه‌های حکمرانی خوب شامل آزادی اقتصادی، آزادی تجاری و آزادی سیاسی بر شاخص عملکرد زیست‌محیطی (EPI) و زیرشاخص‌های آن شامل سلامت محیط، سرزندگی اکوسیستم و تغییرات آب و هوایی بررسی می‌شود. داده‌های مورد نیاز برای تجزیه و تحلیل آماری مربوط به کشورهای منطقه خاورمیانه و شمال آفریقا و ترکیه (MENAT) طی سال‌های ۲۰۲۱-۲۰۰۰ می‌باشد. برای برآورد مدل و بررسی رابطه بین متغیرها از روش داده‌های پانل استفاده شده است. یافته‌ها نشان می‌دهد که بین آزادی اقتصادی و آزادی سیاسی با شاخص عملکرد محیطی (EPI) رابطه مثبت و معناداری وجود دارد و بین آزادی تجاری و EPI رابطه معناداری وجود ندارد. همچنین مشخص شد که آزادی اقتصادی تأثیر منفی بر سرزندگی اکوسیستم و تغییرات آب و هوایی دارد، اما تأثیر مثبتی بر سلامت محیطزیست داشته است. همچنین آزادی سیاسی بر سرزندگی اکوسیستم و تغییرات اقلیمی تأثیر مثبت دارد، اما تأثیر قابل توجهی بر سلامت محیطزیست ندارد. نتایج این تحقیق نشان داد که آزادی اقتصادی منجر به سرمایه‌گذاری بیشتر در بخش نفت و گاز کشورهای مذکور شده است و بنابراین انتشار فاضلاب و گاز تاثیر منفی بر حیات محیطزیست و تغییرات آب و هوایی داشته است، اما با افزایش تولید و فروش نفت و گاز، درآمد سرانه کشورها افزایش یافته و بهداشت محیط بهبود یافته است. همچنین با توجه به اینکه آزادی سیاسی در میان منطقه خاورمیانه و شمال آفریقا از تنوع زیادی برخوردار است، نتایج نشان داد که کشورهای دارای آزادی سیاسی بیشتر، از طریق آگاهی بیشتر جامعه و پاسخگویی بیشتر دولت‌ها و وضع قوانین حفاظت از محیط زیست، از وضعیت محیط زیست بهتری برخوردار بوده‌اند. البته شاخص بهداشت محیط بیشتر تحت تأثیر وضعیت اقتصادی و تولید سرانه کشورهاست و آزادی سیاسی تأثیر چندانی بر آن ندارد.

واژه‌های کلیدی: آزادی اقتصادی، آزادی سیاسی، عملکرد زیست محیطی

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DOI: 10.22067/jead.2023.81572.1184

Journal of Agricultural Economics & Development

Homepage: https://jead.um.ac.ir

Full Research Paper
Vol. 37, No. 2, Summer 2023, p. 177-202

A Flexible Combination Forecast Method for Modeling Agricultural Commodity Prices: A Case Study Iran's Livestock and Poultry Meat Market

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Received: 25-04-2023	**How to cite this article:**
Revised: 17-07-2023	Heydari, R. (2023). A flexible combination forecast method for modeling agricultural commodity prices: A case study Iran's livestock and poultry meat market. *Journal of Agricultural Economics & Development*, *37*(2): 177-202. https://doi.org/10.22067/jead.2023.82122.1187
Accepted: 17-07-2023	
Available Online: 17-07-2023	

Abstract

In recent years, the fluctuation in agricultural commodity prices in Iran is increased and thus, accurate forecasting of price change is necessary. In this article, a flexible combined method in modeling monthly prices of beef, lamb and chicken from April 2001 to March 2021, was proposed. In this new method, three different approaches namely simple averaging, discounted and shrinkage methods were effectively used to combine the forecasting outputs of three hybrid methods (MLPANN-GA, MLPANN-PSO and MLPANN-ICA) together. In implementation stage of hybrid methods, based on test and error method, the optimal MLPANN structure was found with 3/2/4–6–1 architectures and the controlling parameters are carefully assigned. The results obtained from three hybrid methods indicate that, based on the RMSE statistical index, the MLPANN-ICA method performs the best when forecasting prices for beef, lamb, and chicken. The outputs of three combination approaches show that the shrinkage method, with a parameter value of K=0.25, achieves the highest prediction accuracy when forecasting prices for these three meats. In summary, the proposed method outperforms the other three hybrid methods overall.

Keywords: Agricultural commodity prices, Forecasting, Hybrid method, Meat

Introduction

Price is a key factor in the financial and commercial activity of the agricultural sector, in such a way that the activists of the agricultural sector are always exposed to the risks associated by the fluctuation in the price of agricultural products (Hasan *et al*., 2020). The price of agricultural products fluctuates a lot due to factors affecting the demand side and supply side ranging from climatic shocks to political, financial and market shocks. The continuous increase in food prices caused by the rapid increase in demand for food directly threatens more than 800 million people worldwide with chronic malnutrition. As a result, the price of agricultural commodities has attracted the attention of policymakers, academic researchers, and companies to predict the price of food products (Shao and Dai, 2018; Weng *et al*., 2019).

As the share of food expenditure in household expenditure in developing countries is higher than in developed countries, the consequences of fluctuation in food prices are seriously pervasive in terms of food security in such coutries (Timmer, 2014). Recent decades, have witnessed an enormous increase and fluctuation in commodity prices. Volatility in the behavior of commodity prices is typically the result of the increase in the global demands,

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DOI: 10.22067/jead.2023.82122.1187

complex changes associated with cyclical, trend, and random factors and so on (Garganoa and Timmermann, 2013; Tomek and Kaiser, 2014; Chen, 2015). In recent years, the global economy has experienced an increase in the prices of many agricultural commodities. During the period 2006-mid 2008, World agricultural commodity prices considerably increased, so that the prices of commodity crops nearly doubled (Nazlioglu, 2011; Ajmera *et al*., 2012). As indicated by Fowowe (2016), prices of agricultural commodities particularly experienced enormous increase up to 64 percent in the period from 2001 to 2013. Also, Dreibus *et al.* (2014) found that in a past decade, food prices have increased by 2.8% per year on average. Ascendant trend in the prices of agricultural commodity can increase concern for countries that rely on food imports (Nazliogl and Soytas, 2011).

In recent years, the prices of agricultural goods have experienced significant increases due to multiple factors, including the global spread of Covid-19 and the ongoing conflict in Ukraine. This upward trend in agricultural prices has raised substantial concerns among countries that rely on food and agricultural imports, as noted by the FAO in 2022. Additionally, Asian economies, such as Iran, have also witnessed volatility and upward trends in the prices of agricultural commodities. For instance, Figure 1 illustrates the monthly price changes in various meat types in Iran from 2018 to 2021, clearly showing the presence of this volatility and upward trajectory. It is worth noting that a significant portion of the rise in agricultural commodity prices can be attributed to inflation, which, in turn, is a consequence of various factors, including governmental financial mismanagement, shifts in internal policies, chronic budget deficits, unregulated money creation by the banking sector, the discussions surrounding the Joint Comprehensive Plan of Action (JCPOA), the imposition of sanctions against Iran, the global impact of Covid-19, the ongoing conflict in Ukraine, and other related factors. The cumulative effect of these factors has resulted in a severe budget deficit within the Iranian government. Consequently, this budget deficit has become the primary driver of the expansion of the monetary base and a sharp increase in inflation, particularly in the prices of food items in Iran.

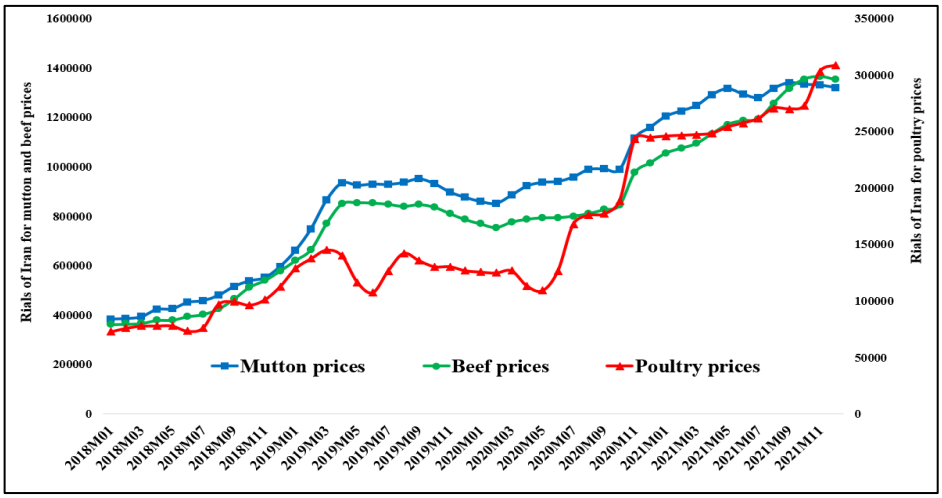


Figure 1- The changes trend in prices of meat types in Iran (Agriculture Ministry of Iran, 2021)

Price changes forecasting is a challenge in economic decision making, because the fluctuation of prices is affected by different factors (Wu *et al*., 2017). One of main targets of commodity price forecasting can be linking of between theory and practice, improving decision-making and risk management in industries that heavily reliant on commodity markets. This aims provides useful information to both policy makers and decision markers (No

and Salassi, 2009; Mohamed and Al-Mualla, 2010). Also, because of price forecasts play a key role in public policy and are designed to influence human activity, are important (Allen *et al*., 2016).

The price forecasting of agricultural commodities is considered as an important and essential component in market management and decision planning, due to it can provide the simulated perspective of future, and identifying the balance in the supply and demand of agricultural commodities. In addition, agricultural commodity prices forecasting allowed producers to make better decisions, to help to optimize their commodity selling strategy, and to manage price risk. In the agricultural commodity market, the accurate forecasting of the price of agricultural commodities is challenging because of prices time series are very complex, highly volatile (Kantanantha *et al*., 2010; Mohamed and Al-Mualla, 2010; Xiong *et al*., 2015). Thus, an accurate forecasting method is needed for forecasting of the price of agricultural commodities which can avoid many disasters related to the demand and supply of agricultural commodities; and for farmers' production decision, consumers' low economic losses and government regulation (Ye *et al*., 2014; Yang *et al*., 2016).

Given the paramount importance of forecasts for both policymakers and decision-makers, extensive research has been conducted over the past decades to develop forecasting methods. These methods have evolved from simple models to more complex ones, as noted by Aiolfi and Timmermann in 2006. Currently, there exists a wide variety of models designed for forecasting agricultural commodity prices. In the study conducted by Wu *et al*. in 2017, the forecasting models for agricultural commodity prices were categorized into two main types: structural models and non-structural methods. Furthermore, short-term forecasting methods for agricultural commodity prices encompass a range of approaches, including time series methods such as the ARIMA model, regression methods like the vector auto-regression model, and machine learning methods, including neural networks. Although, traditional methods have extensively used to forecast the agricultural commodity prices, but these methods have contained weakness, as following:

1. Traditional methods that are applied to predict commodity prices, are based on the certain probability distribution, while this assumption may be unreasonable and non-rational (Atsalakis, 2014).

2. In most cases, time series for the price of agricultural commodities is nonlinear and non-stationary due to the intrinsic elaboration and volatility of these prices, thus the linear structure of traditional methods cannot properly forecast the nonlinear behaviors of time series of agricultural commodity prices (Xiong *et al*., 2015; Yang *et al*., 2016).

3. Time series methods (e.g. ARIMA model) are only based on observations of the same variable are collected and analyzed, (history prices of agricultural commodities) and random variables, therefore, these methods ignored other factors (not consider exogenous economic variables) that may affect agricultural commodity prices (Shahwan and Odening, 2007; Wu *et al*., 2017).

4. More current methods have focused on a single model and can only be applied in a small-scale data, consequently reduces the accuracy of the forecasting of agricultural commodity prices (Stock and Watson, 2004; Wu *et al*., 2017).

The early 1980s, artificial neural networks (ANN) have been suggested as an alternative technique to overcome the weaknesses of traditional models. Many researchers have started to apply ANN methods to forecast economic and financial applications due to the significant properties of handling nonlinear data with self-learning capabilities (Shahwan and Odening, 2007; Chen *et al*., 2010; Atsalakis, 2014). Also, there are a number of studies in which ANNs are used to develop forecasting models of agricultural commodity prices. More this studies demonstrate that ANN models can outperform the statistical forecasting techniques and can sometimes also outperform some other non-linear models (Das

and Padhy, 2015; Pannakkong et al., 2016).

Artificial neural network model is an information processing system that was developed based on the structure of human brain neuron working (Atsalakis, 2014; Pannakkong *et al*., 2016). ANN model has considerable advantages into traditional statistical methods, such as self-learning, not making assumption of characteristic of the data, expressing highly non-linear relationship between the input and output data that can't be modeled in mathematics, generalizing at high speed, adapting and using only many parameters, and so on (Mollaiy-Berneti, 2015; Pannakkong *et al*., 2016). Notwithstanding above advantages, there are some problems for ANN model that many researchers criticize the performance of it. For example, the convergence in the training of ANN method is generally slow and the specification of ANN method carried out by trial and error technique. It is not able to determine the grade to which an input affects the output of the ANN model (Karimi and Yousefi, 2012; Amiri *et al*., 2015). When ANN model is specially used for forecasting the price of different agricultural commodities, its results cannot be ensured and overvaluing may happen. Thereupon, it may be some errors in the ANN method outputs (Wu *et al*., 2017).

Due to the complexity of real-world problems in nature and variety existence in characteristics of commodity prices such as seasonality, heteroskedasticity or a non-Gaussian error, using of a hybrid model can be a suitable alternative for forecasting commodity prices (Shahwan and Odening, 2007). The optimization of ANN model with evolutionary algorithms (ANN-EA) is the most important hybrid model that is used by researchers. In fact, one of suitable ways to overcome problems of ANN model and improve reliability of network, is usage of optimization methods such as evolutionary algorithms to optimize the network initial weights. Therefore, to reduce the weakness related to ANN methods, some evolutionary algorithms such as Genetic Algorithm (GA), Particle Swarm Optimization algorithm (PSO) and Imperialist Competitive Algorithm (ICA) can be used for the optimization of the ANN structure. On the other hand, evolutionary algorithms can use to optimize linking weights and the obtained outputs of neural network (Ahmadi *et al*., 2015; Xiong *et al*., 2015; Kartheeswaran and Christopher Durairaj, 2017).

Commodity price forecasting using of the hybrid model of ANN-EA have problems. The choosing of the free parameters related to evolutionary algorithms in training the neural network using of evolutionary algorithms (e.g. PSO, GA, ICA), are typically based on cut and try, domain knowledge and ergodic search methods. Thus, the hybrid model of ANN-EA needs to determine controlling parameters and this task causes more complex. Therefore, variations to the controlling parameters alter the effectiveness of the optimization algorithm (Das and Padhy, 2015). Moreover, as indicated by Stock and Watson, (2004), the use of an individual model to forecast is rather unstable over time. Also, the results of this study show that the use of a type of the ANN-EA hybrid model cannot be appropriate to forecast different variables (agricultural commodities price). To overcome these limitations, combination methods can be used as an alternative to increase the accuracy of forecast models. Stock and Watson, (2004) found that the performance of the individual forecasts was unstable and most of the combination forecasts have lower mean squared forecast errors (MSFEs) than the individual models. Despite the formidable ability of hybrid methods, not unexpected that each of this hybrid methods still are not able to get desired results because of their drawbacks. Therefore, by considering the ability of each of this hybrid methods, the methodology and technique of the combination ways of hybrid models are necessity for the better forecasting of economic variables. Hybrid and combined methods have focus on different aspects. For instance, hybrid methods apply processes of noise reduction, seasonal adjustment and cluster on data, while ways of combination use of weight coefficients of individual methods (Rapach and Strauss, 2009; Yang *et al*., 2016). Thus, the hybrid models as

individual methods can combine by combined methods. The obtained proportion coefficient of hybrid models can be adjusted in the combined method, so that the results can be the best (Aiolfi and Timmermann, 2006; Yang *et al*., 2016). To improve the accuracy of forecasting, some combined methods have been applied in several applications. For example, Stock and Watson, (2004) and Aiolfi and Timmermann (2006) used from three types of combination forecast methods, including simple averaging method, discounted method, shrinkage method. This three of combination forecast methods are considered in this study.

While numerous methods have been developed for forecasting agricultural commodity prices, the application of combination forecasting has not received extensive attention. Hence, this study aims to explore the forecasting accuracy of livestock and chicken meat prices by introducing a novel combination-hybrid prediction method. In this proposed method, we employ evolutionary algorithms such as Genetic Algorithms (GA), Particle Swarm Optimization (PSO), and Imperialist Competitive Algorithm (ICA) to train Artificial Neural Network (ANN) models. Additionally, we assess whether the out-of-sample forecasts generated by this combination method exhibit greater accuracy and reliability compared to forecasts generated by individual hybrid methods, using various statistical indexes. It is important to note that there is limited existing research and infrequent scientific exploration into the forecasting capabilities of Iran's agricultural commodities market. Therefore, this research is expected to contribute significantly to filling this research gap.

Our experimental findings clearly demonstrate that the method proposed in this paper outperforms its individual components, yielding highly effective forecasts for agricultural commodities in the Iranian agricultural markets. Both error analysis and visual result analysis support the conclusion that the combination-hybrid model introduced in this paper achieves commendable forecasting outcomes. This combination-hybrid model not only enhances forecasting accuracy but also significantly improves efficiency when compared to other hybrid models comprised of its individual components. Additionally, the advantages of the method proposed in this paper can be summarized as follows:

1. Among agricultural commodities price forecasting methods, this method is flexible and has the great forecasting accuracy.

2. This method can be used to forecast many types of agricultural commodities with good performance.

The following sections provide a brief overview of the content covered in each sector: In Section 2, previous studies regarding commodity prices forecasting are surveyed. In Section 3, we delve into the intricacies of the data processing procedures and present the outcomes of our preliminary data analysis. Following that, in the fourth section, we provide a detailed illustration of the proposed combination-hybrid prediction method. Within this section, we expound upon the key components of our proposed method, which encompass Multilayer Perceptron Neural Networks (MLPNN), various evolutionary algorithms such as Genetic Algorithms (GA), Particle Swarm Optimization (PSO), and Imperialist Competitive Algorithm (ICA), as well as the combination techniques applied to hybrid models. Each of these elements is described in depth, offering a comprehensive understanding of their roles and contributions to the overall methodology. Section 4 illustrates forecasting statistical criteria. In Sections 5, experimental results are discussed and a final section (Section 6) concludes this work.

Background study

To date, some researchers have reported the use of traditional methods, the types of ANN models, and combination and hybrid methods for commodity prices modeling and forecasting. For example, Zou *et al.* (2007), Obe and Shangodoyin (2010), Pokterng and Kengpol (2013) and Pannakkong *et al.* (2016), for predicting agricultural commodity prices utilized ANN model. Several studies have yielded results indicating that Artificial Neural

Network (ANN) models tend to outperform well-established statistical forecasting methods. Additionally, when it comes to forecasting commodity prices, a variety of papers have explored the application of combination and hybrid methods, as exemplified below: In a study conducted by Wihartiko et al. (2021), an examination of models used for predicting the prices of agricultural products revealed that Artificial Intelligence, Data Mining, and Regression models were utilized at rates of 30%, 22%, and 18%, respectively. Moreover, for forecasting agricultural product prices, intelligent models were proposed, taking into account the concept of the supply chain. Raflesia et al. (2021) employed the PSO-RBFNN (Particle Swarm Optimization-Recurrent Neural Network) model in their research to predict agricultural commodity prices in Indonesia. The outcomes of this study demonstrated that the predictive accuracy of the PSO-RBFNN model surpassed that of competing models. In a study by Nosratabadi et al. (2020), it was shown that the combined ANN-GWO (Artificial Neural Network-Gray Wolf Optimization) model exhibited higher prediction accuracy when compared to the ANN-ICA (Artificial Neural Network-Imperialist Competitive Algorithm) model. These findings collectively underscore the effectiveness of ANN models and the potential benefits of combining them with various optimization algorithms for improved commodity price forecasting. Wang *et al.* (2018) used a hybrid model to forecast the monthly price of Chinese garlic during 2010-2017. Their proposed model consisted of an Autoregressive Integrated Moving Average (ARIMA) model as the linear part and the Support Vector Machine (SVM) model as the non-linear part of the proposed model. The results of this study showed that the hybrid ARIMA-SVM model has a better performance in predicting the price of garlic than the ARIMA and SVM models, and it can be used as an effective method for predicting the short-term price of garlic. Tian *et al.* (2017) developed a time-varying HAR model to forecast the realized volatility in the agricultural commodity futures markets of China. The authors used six agricultural commodity futures namely soybean, cotton, gluten wheat, corn, early Indica rice and palm futures and employed daily data of all sample periods. Their results showed that the proposed HAR model has better performance than both the simple HAR model and more sophisticated HAR-type models in almost all cases. Wu *et al.* (2017) proposed a mixed model, which combines ARIMA model and PLS regression method to forecast the weekly prices of agricultural commodity from January 2, 2014 to June 30, 2015 in Beijing. Their results displayed the proposed mixed model is more accurate in forecasting the prices of agricultural commodity than each single model does. Ahumadaa and Cornejo (2016) examined forecasting improvements of individual food price models by taking into account the cross-dependence of the commodities (including corn, soybeans and wheat) in the period 2008–2014. Their results indicated forecasting accuracies of models that include price interactions, can be improved. Das and Padhy (2015) developed a new hybrid SVM–TLBO method, that combines a support vector machine with teaching-learning-based optimization, to forecast commodity futures index (consist of futures prices of metals, energy, and agricultural commodities). Their experimental results illustrated that the proposed model outperforms the particle swarm optimization PSO-SVM hybrid and standard SVM models. Xiong *et al.* (2015) applied the combination method of vector error correction model with multi-output support vector regression (VECM–MSVR) to interval forecasting of agricultural commodity futures prices in China, and their results indicated the proposed method is a promising alternative for forecasting this futures prices. Atsalakis (2014) proposed a hybrid intelligent system called the Adaptive Neuro Fuzzy Inference System (ANFIS) to forecast monthly prices of four agricultural commodities (wheat, sugar, coffee, and cocoa). The experimental results of author's study showed that the neuro-fuzzy method outperforms the other feedforward such as

neural network (NN), the two traditional methods AR and ARMA. Ye *et al.* (2014) used the optimal combination model to forecast vegetable price in Hainan. This proposed model included from three models are triple exponential smoothing model, simple linear regression model, and grey forecasting model. This study's forecasting results indicated the forecasting accuracy of the proposed combination model is better to each individual model and overcomes on of limitation of individual models. Garganoa and Timmermann (2013) examined the out-of-sample forecasting of commodity price indexes by means of macroeconomic and financial variables over the period 1947–2010. They found that the out-of-sample forecasting of commodity prices is strongest for industrials, metals, and the broad commodity index; while is weaker for fats/oils, foods, and livestock. Kantanantha *et al.* (2010) develop accurate yield and price forecasting models for stochastic crop decision planning. To overcome on existing difficulty, they developed Functional Principal Component Analysis (FPCA) and a futures-based model for yield and price forecasting and applied these methods to corn yield and its price for Hancock County in Illinois. They found that their forecasting results are more accurate in comparison to predictions based on existing methods. Ticlavilca *et al.* (2010) applied the Multivariate Relevance Vector Machine (MVRVM) model to forecast the prices of agricultural commodities. Authors used the monthly price data of cattle, hog and corn that were obtained for a period of 21 years (from 1989 to 2009). Also, proposed method is based on a Bayesian learning machine approach for regression. In their study, the efficiency and accuracy of the MVRVM model is compared with artificial neural network model. Shahwan and Odening (2007) used a hybrid model that combines a seasonal ARIMA model and an Elman neural network (ENN) to forecast agricultural commodity prices (including hog and canola prices from Germany). They employed a genetic algorithm (GA) to determine the optimal architecture of the ANNs. Their results showed that the out-of-sample forecasting be improved somewhat with the proposed hybrid method.

The comprehensive review presented above suggests that combination and hybrid methods consistently outperform traditional methods and various types of Artificial Neural Network (ANN) models in the context of commodity price forecasting. Furthermore, it becomes evident that a method with the distinctive features of the proposed approach in this study, aimed at enhancing the prediction accuracy of hybrid methods involving neural networks and evolutionary algorithms through the use of individual combined techniques, has not been previously explored for predicting agricultural commodity prices. This underscores the novelty and potential significance of the approach outlined in this study, which seeks to advance the state of the art in commodity price forecasting by integrating the strengths of neural networks and evolutionary algorithms in a unique and promising manner.

Materials and Methods

The novel proposed method

There are several methods available for forecasting commodity prices, including time series methods, classical statistic methods, artificial neural networks methods and hybrid methods. To the best of authors' knowledge, there is no published work in the literature that is similar to the novel proposed method presented in this paper. This study takes advantage of different hybrid methods and combination approaches, and proposes a novel combined-hybrid method. This new method consists of two categories of individual methods and combination approaches. In this proposed method, combination approaches were used to adjust the weight coefficients and consequently to combine the forecasting outputs of individual methods and it should be assumed that the combination approaches able to recognize most of the seasonal, linear and nonlinear patterns. Individual methods included three hybrid methods of ANN-AE where MLPNN model combined with Genetic Algorithm (MLPNN-GA), Particle Swarm Optimization algorithm (MLPNN-PSO) and

Imperialist Competitive Algorithm (MLPNN-ICA). Combination approaches consist of simple averaging method, discounted method and shrinkage method. One of advantages of novel method is flexibility in increase (or decrease) of number of hybrid methods and combination approaches. Fig. 2 illustrates the details on combined method used in this study. According to Fig. 2, input data contains agricultural commodity prices (in this study including prices of beef, lamb and chicken).

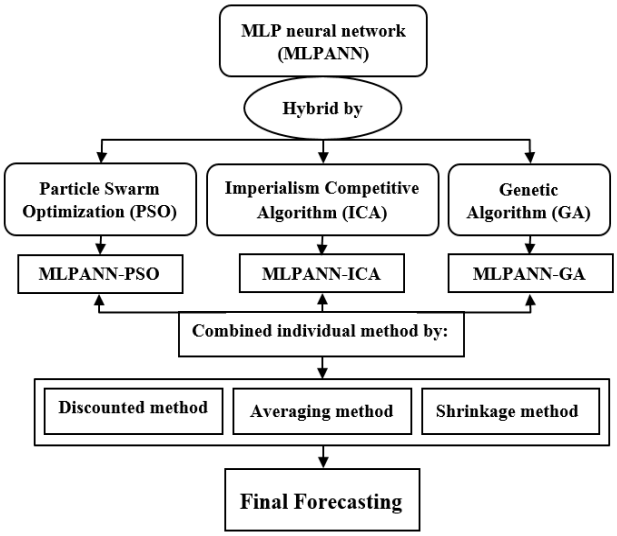


Figure 2- Illustration of the proposed combination method

There steps of performance of the proposed method are as below:

1) Inserting data to three hybrid methods of MLPANN-EA; after several times of training and testing, and then get the forecasted data from each of them separately.

2) Applying three combination approaches to adjust the weight coefficients between the three hybrid methods;

3) Comparing the proposed combined method with the other three individual using the criteria of Root Mean Square Error (RMSE).

Hybrid methods of Multilayer Perceptron Neural Network with evolutionary algorithms

In order to overcome limitations related to ANN training, i.e. powerful technique for training, several different types of training algorithms are developed. Hybrid methods of combination ANNs with evolutionary algorithms such as genetic algorithm (GA), particle swarm optimization (PSO) and imperialism competitive algorithm (ICA) are capable of adjusting the weight and bias of ANNs, moreover, these approaches have been widely used in the prediction of economic variables (Karimi and Yousefi, 2012; Amiri *et al*., 2015; Mollaiy-Berneti, 2015; Khandelwal *et al*., 2017; Jahed Armaghani *et al*., 2017).

In this study, three types of evolutionary algorithms, including GA, PSO and ICA are employed as a training algorithm for training multilayer perceptron neural network and updating the weights and biases.

Multilayer Perceptron Neural Network (MLPNN)

The MLPNN is formed from a group of elements known as ‘neurons’ or ‘nodes’ that place at least in three types of layers including an input layer, a hidden layer and an output layer. The input layer contains the independent variables and the output layer receives the dependent variable. The number of neurons in the input and output layers shows the number of independent variables used for forecasting and a variable to be forecasted, respectively. The

hidden layer is placed between the input and output layers and contains processing neuron. A hidden layer is enough to resolve similar or more complex problems. The most public method to determine the number of nodes per hidden layer is trial and error approach. The mathematical formulation of the relationship between the inputs (x_i) and the output (y) as follows:

$$y = f(b + \sum_{i=1}^{k} w_i x_i) \quad (1)$$

Where y is the output vector, x_i the input vector, w_i the weight of the neural model, b the bias, and f is the activation function. This activation function can take many forms. Suitable approach for the determination of activation functions of layers are through testing (Sangwan *et al*., 2015; Amiri *et al*., 2015; Heddam, 2016; Johns and Burkes, 2017; Pham Dieu *et al*., 2017; Mohammadi Ghahdarijani *et al*., 2017). In this work, the activation functions of both the input and hidden layers and the output layer are hyperbolic tangent sigmoid transfer function (tansig) and linear transfer function (purelin), respectively (Lazzus, 2011).

Evolutionary Algorithms

Genetic Algorithm (GA)

Genetic algorithm (GA) is one of the optimization methods, which is developed by Holland (1975). Genetic algorithm is a stochastic and heuristic search technique based on the biological evolution's process of in natural and imitates from the mechanic of natural genetics. This algorithm designed to solve complex problems of linear and non-linear optimization using the generation of potential solutions (Raikar *et al*., 2016; Kisi *et al*., 2017).

Particle Swarm Optimization (PSO) Algorithm

The Particle Swarm Optimization (PSO) algorithm is a stochastic-population-based evolutionary computer algorithm is applied for the solution of complex and nonlinear optimization problems. PSO algorithm is inspired from social behavior of some animals such as fish schooling and bird flocking in nature. Some benefits of PSO algorithm are the ability of searching the spacious optimum with high convergence rate, simple and inexpensive coding, and the compatibility with the value change of the best group (Gaur *et al*., 2013; Chandrasekaran and Tamang, 2017)

Imperialist Competitive Algorithm (ICA)

Imperialist Competitive Algorithm is a novel meta-heuristic evolutionary algorithm to solve various optimization problems that was developed by Atashpaz-Gargari and Lucas (2007). ICA, as a global search population-based technique, is inspired from the social-political behavior of human and uses the advantages of political, cultural and social evolution in optimization processes. ICA method is very similar to genetic algorithm and has upper ability to obtain the convergence rate and the optimal solution (Jahed Armaghani *et al*., 2017; Kisi *et al*., 2017)

Combination Forecast Methods

The topic of combined forecasting method is the process of merging information related to the individual methods that can improve the forecast reliability of economic variables, such as prices. It is important to determine the weight coefficients of each single method in the combined method, so that with obtaining suitable weight coefficients can attain good forecasting outputs. The combined forecasting method states that if there exist three kinds of forecasting individual methods (hybrid methods) including MLPANN-GA, MLPANN-ICA and MLPANN-PSO, they can be added up as follows:

$$\hat{Y}_{combined(t)} = \omega_1 \hat{Y}_{MLPANN-GA(t)} + \omega_2 \hat{Y}_{MLPANN-PSO(t)} + \omega_3 \hat{Y}_{MLPANN-ICA(t)} \quad (2)$$

Where $\hat{Y}_{combined(t)}$, $\hat{Y}_{MLPANN-GA(t)}$, $\hat{Y}_{MLPANN-PSO(t)}$ and $\hat{Y}_{MLPANN-ICA(t)}$ are the forecasting outputs at period t by the combined method, MLPANN-GA, MLPANN-PSO and MLPANN-ICA, respectively, and ω_i (i = 1, 2, 3) is the weight coefficient allocated to MLPANN-GA, MLP-ANNPSO and

MLPANN-ICA methods at period t, respectively; with the assumption of $\sum_{i=1}^{3}\omega_i = 1$.Weight coefficient depends on the historical performance of each hybrid methods, thus, sample data divided into two periods. First period contains data that only are used for estimation and training of each hybrid methods: [1, T], and second data are used for computing weight coefficient and final forecasting: [T+1, …, n] (Stock and Watson, 2004; Rapach and Strauss, 2009; Yang *et al*., 2016). In the present paper, we consider out-of-sample combination forecasts of monthly price of meat types in Iran. For each hybrid methods, let Y_t be the price of meat types (beef, lamb and chicken).

Next subsection describes four types of combined methods that are considered in this paper. The difference between these methods lies in how historical information is used to compute the combination forecast.

Simple averaging method

The first class of combined methods is simple averaging schemes. This method divides to three categories: the mean, median, and trimmed mean. The mean method is equally distributing the weight coefficients in the combined method, so that in Eq. 2 $\omega_1 = \omega_2 = \omega_3 = 1/3$ is allocated. In most cases, the equal weight coefficients may not have the appropriate forecasting outputs. The median method is the set median of $\hat{Y}_{MLPANN-GA(t)}$, $\hat{Y}_{MLPANN-PSO(t)}$ and $\hat{Y}_{MLPANN-ICA(t)}$. In the trimmed mean method, through $\hat{Y}_{MLPANN-GA(t)}$, $\hat{Y}_{MLPANN-PSO(t)}$ and $\hat{Y}_{MLPANN-ICA(t)}$, for each other with the smallest and largest values, the set of $\omega_i = 0$. Whereas there exist three hybrid methods, the results of both median method and trimmed mean method is similar (Stock and Watson, 2004; Rapach and Strauss, 2009; Yang *et al*., 2016).

Discounted method

According to the basic framework of Stock and Watson (2004), the discounted method uses the following weight coefficients:

$$\omega_i = n_i^{-1} / \sum_{j=1}^{3} n_j^{-1} \quad (3)$$

$$n_i^{-1} = \sum_{s=T+1}^{T+n} \gamma^{T+n-s} (Y_s - \hat{Y}_{i.s})^2 \quad (4)$$

Where γ is a discount factor, Y_s is actual values of out-of-sample and $\hat{Y}_{i.s}$ is forecasting values of out-of-sample for each hybrid method. In this method, greater weights are allocated to hybrid methods that have lower RMSE values (Stock and Watson, 2004; Rapach and Strauss, 2009; Costantini and Pappalardo, 2010). By following from Stock and Watson, (2004), we consider values of .9, 0.95 and 1.0 for discount factor.

Shrinkage method

The weight coefficients of shrinkage method are based on the average of the OLS estimator of the weights. Shrinkage method takes the form:

$$\omega_i = \mu\hat{\beta}_i + (1-\mu)(1/m) \quad (5)$$

$$\mu = \max\{0.1 - k[m/(t-(T+1))]\} \quad (6)$$

Where $\hat{\beta}_i$ is the ith estimated coefficient from OLS regression of Y_s on $\hat{Y}_{MLPANN-GA(t)}$, $\hat{Y}_{MLPANN-PSO(t)}$ and $\hat{Y}_{MLPANN-ICA(t)}$, imposing an intercept of zero (no intercept). In Eq. 6, m is the number of hybrid methods (m=3) and k is a constant amount that conducts shrinkage method towards same weighting (Stock and Watson, 2004). By following from Stock and Watson (2004) for k is consider amounts of 0.25, 0.5, 0.75 and 1.0.

Forecasting criteria

Forecasting combination methods are typically assessed using standard statistical. In this study, Root Mean Square Error (RMSE) was used. This criteria measure the deviation between the actual and forecasted data, so that the model with the lowest value of RMSE is denoted as the best model. Detailed descriptions and definitions of this performance criteria is can be calculated as follows:

$$\text{RMSE} = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(Y_i - \hat{Y}_i)^2} \quad (7)$$

Where, Y_i is the actual value, $\hat{Y}_i$ is the forecasted value, $\bar{Y}_i$ is the mean of the actual value and n represents the time period of forecasting (Das and Padhy, 2015; Yang *et al*.,

2016; Jahed Armaghani *et al*., 2017). To obtain the results of the applied methods, this study utilized MATLAB software.

Dataset

In this study, the data required for analysis consists of both dependent and independent variables. The dependent variable under investigation pertains to the prices of agricultural goods, specifically focusing on the prices of various meat types in Iran. On the other hand, the independent variables comprise lagged prices, which exert an influence on the prices of agricultural commodities. To identify these lagged prices, an Autoregressive model (AR) was employed. For the monthly price data of beef, lamb, and chicken, the optimal lag lengths were determined as follows: a lag of 3 months for beef, a lag of 2 months for lamb, and a lag of 4 months for chicken. The dataset used in this study encompasses monthly price observations for these meat types, spanning the time period from April 2001 to March 2021. The data of prices of meat type for this study consist of beef, lamb and chicken in agricultural market and these data were collected from Ministry of Agriculture in Iran (2021). The statistical descriptions of three agricultural commodity prices are shown in Table 1. This table describes the data set of prices in terms of mean, maximum, minimum, standard deviation, kurtosis (measure of flatness of the distribution), and skewness (degree of asymmetry of a distribution near its mean). Examining the minimum and maximum of prices indicate a big difference between them. Also, the mean, standard deviation, skewness and kurtosis show that prices demonstrate high fluctuation. In totality, the data description in Table 1 present the data have high variation.

Table 1- The statistical descriptions of real prices of beef, lamb and chicken

Parameter	Beef	Lamb	Chicken
Mean	277295.6	296770.2	62434.67
Median	111845.5	143985.5	33722.5
Maximum	1440806	1458052	308717
Minimum	21389	21368	8943
Std. Dev.	337085.4	363096.8	66963.78
Skewness	1.79	1.71	2.1
Kurtosis	5.42	4.84	7.04
Jarque-Bera	195.56 (0.00)	158.77 (0.00)	356.74 (0.00)

Source: Research findings

Note: Value of prices are expressed in Iranian Rials

For assessing the forecasting performance of new proposed method, respectively, 80 and 20 percent of data was distributed to training and testing sets. Also, the normalization of data to ensure the variation uniform of input variables and prevent variable scattering was followed as Equation 8: (Hooshyaripor *et al*., 2015; Shojaie *et al*., 2016):

$$Z_i = \frac{2(Y_i - Y_{min})}{(Y_{max} - Y_{min})} - 1 \qquad (8)$$

Results

The forecasting results of hybrid methods

Hybrid methods structure due to its impacts on the estimated values, is an important topic that needs consideration. In this study, the determination of hybrid methods structure simultaneously performs in two aspects: MLPNN structure and evolutionary algorithm structure. In current study, prices of meat types (beef, lamb and chicken) were modeled using three different hybrid methods, MLPANN-GA, MLPANN-PSO and MLPANN-ICA. In this work, the evolutionary algorithms of GA, PSO and ICA were used to optimize the connection weights of the MLPANN. In fact, The MPLANN model was trained and optimized by GA, PSO and ICA algorithms to estimate prices of meat type by using of input parameters (the price lag of meat type). Various settings in adjustment of the optimization parameters of these methods (Initializing parameters) is represented in Table 2.

Indeed, the number of neurons in the input

and output layers of a Multilayer Perceptron Artificial Neural Network (MLPANN) model corresponds to the number of input and output variables, respectively. However, determining the optimal number of hidden layers and neurons within those layers is a task that depends on the complexity of the problem at hand, and there is no one-size-fits-all method for determining them. Several studies, such as Hornik et al. (1989) and Ahmadi et al. (2015), have demonstrated that a single hidden layer with an adequate number of neurons can often yield favorable accuracy in MLPANN models. In your study, you explored various architectures, specifically 3/2/4-x-1 architectures, with one hidden layer and a varying number of neurons (x ranging from 1 to 10). Here, the 3/2/4 inputs represent the number of effective lag observations for each meat type, namely beef, lamb, and chicken, respectively. The network has one output for each of these meat types, representing their respective prices. After conducting multiple experiments and testing different configurations, it was determined that setting the number of hidden layer neurons to 6 yielded the best results. Through a trial-and-error approach, it was further confirmed that the MLPANN architecture with 3/2/4–6–1 (3/2/4 input units, 6 hidden neurons, and 1 output neuron) produced superior results compared to other parameter values, demonstrating its effectiveness in addressing the problem at hand.

Table 2- Parameters used in structure of the optimized MLPANN-GA, MLPANN-PSO and MLPANN-ICA

The type of method	The type of parameter	Value
MLPANN	Number of input neurons	Beef: 3/Lamb: 2/Chicken: 4
	Number of hidden neurons	6
	Number of output neurons	1
	Training algorithm	GA, PSO and ICA
GA	Population size	150
	Max number of generation	20
	Recombination rate	0.15
	Crossover rate	0.5
	Mutation rate	0.35
PSO	Number of particles (Swarm size)	20
	Number of max iteration	20
	C_1 and C_2 in Eq. 2	2
ICA	Number of initial countries	20
	Number of initial imperialists	30
	Number of decades	20
	Revolution rate	0.3
	ξ (Zeta)	0.02

Source: Research findings

After determining optimal values of parameter's hybrid methods, three these methods were trained for prices of beef, lamb and chicken. Predicted prices of beef, lamb and chicken in training stage of MLPANN-GA, MLPANN-PSO and MLPANN-ICA methods is shown in Fig. 3, 4 and 5. Also the extent of the match between the observed prices and predicted prices of these meat is shown in Figs. 6, 7 and 8, According to the few number of training data (about 252 observations for each type of meat), can be seen in Figs. 3 to 8 that these hybrid methods institute an acceptable relationship between observed prices and predicted prices and well approximate corresponding prices data. This relationship shows that hybrid methods of MLPANN with evolutionary algorithm has a successful implementation to map the nonlinear behavior of prices (output). Also, from the scatterplots of the simulations are given in Figs. 6, 7 and 8, it is clear that the simulation of three methods for beef prices is better than lamb and chicken prices. In addition, for all three types of meat, the MLPANN-ICA method is better than two other methods in simulation of prices.

In order to compare the performance of three hybrid methods together, the new data sets (remainder 20% which were not used for the training stage) are used as the testing sets. Fig. 9 demonstrate the results of forecasting values of MLPANN-GA, MLPANN-PSO and MLPANN-ICA methods for data of observed prices in test period. It is noted that, considering the 3/2/4 lag of prices of each beef, lamb and chicken as independent variable, 3/2/4 of forecasting values of these methods is cut and 47, 48 and 46 predicted values is remained.

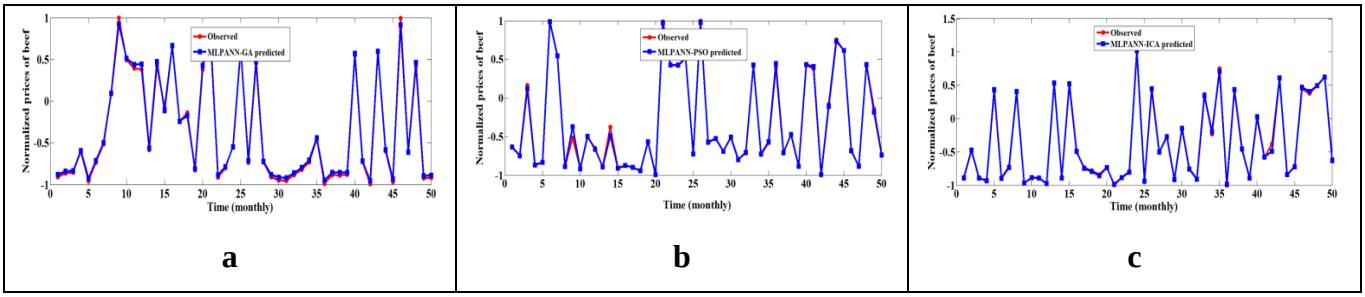


Figure 3- Graphs of the observed and predicted prices of beef by MLPANN-GA (a), MLPANN-PSO (b) and MLPANN-ICA (c) methods in training period

Source: Research findings

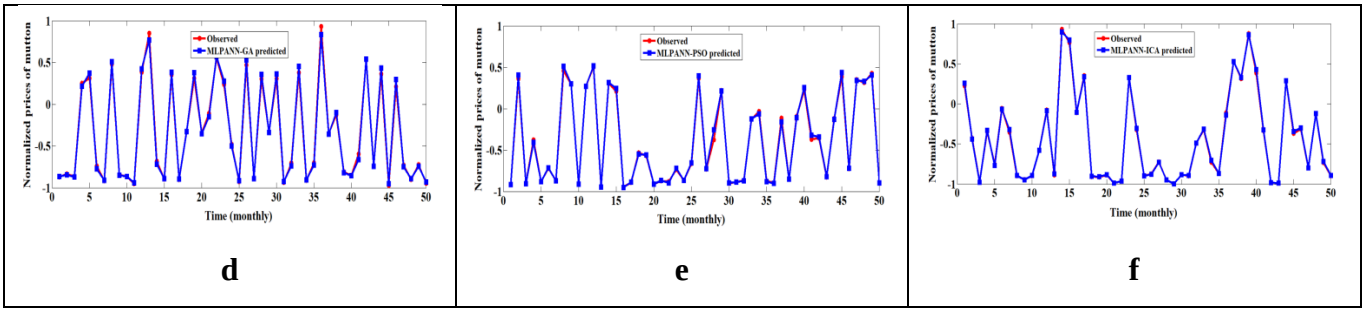


Figure 4- Graphs of the observed and predicted prices of lamb by MLPANN-GA (d), MLPANN-PSO (e) and MLPANN-ICA (f) methods in training period

Source: Research findings

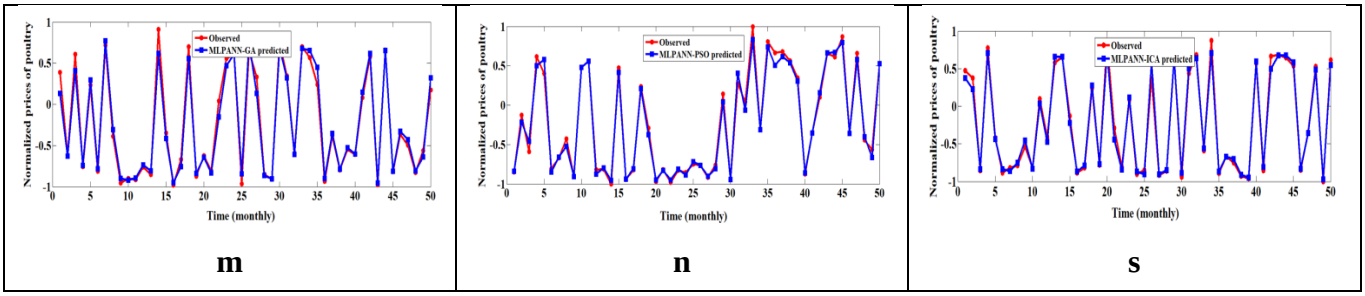


Figure 5- Graphs of the observed and predicted prices of chicken by MLPANN-GA (m), MLPANN-PSO (n) and MLPANN-ICA (s) methods in training period

Source: Research findings

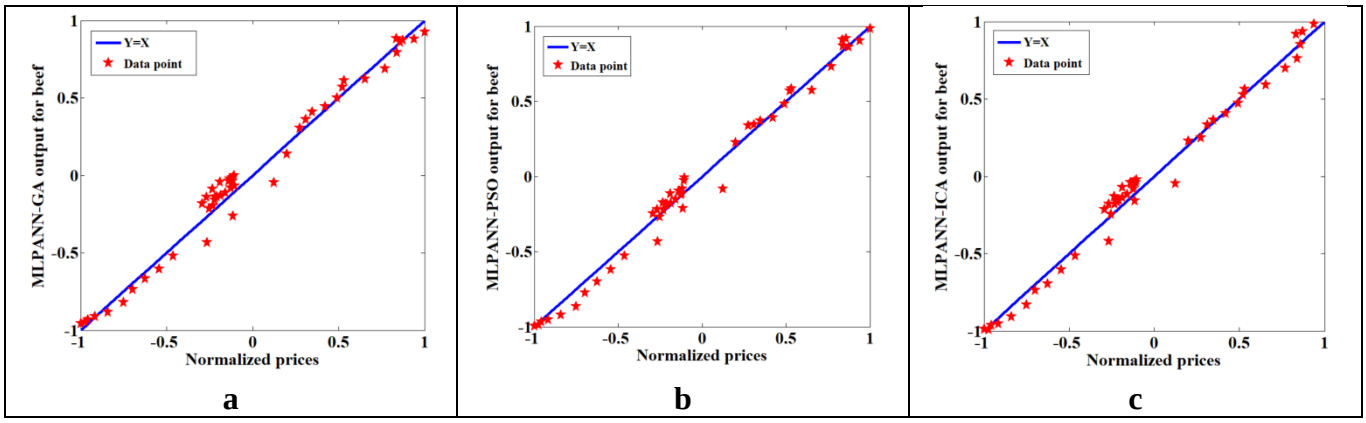


Figure 6- The performance of predicted prices of beef versus the observed prices by MLPANN-GA (a), MLPANN-PSO (b) and MLPANN-ICA (c) methods in training period

Source: Research findings

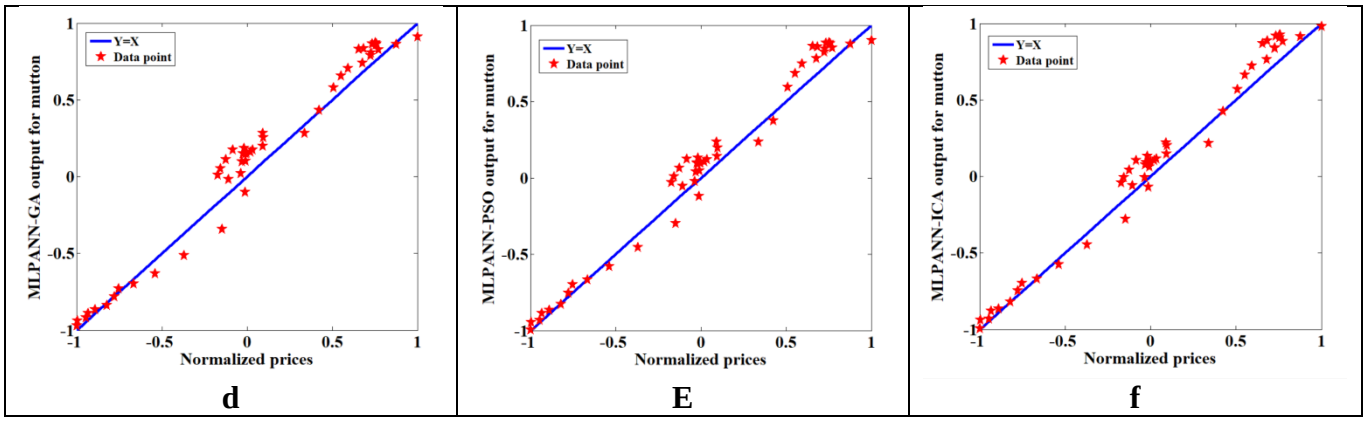


Figure 7- The performance of predicted prices of lamb versus the observed prices by MLPANN-GA (d), MLPANN-PSO (e) and MLPANN-ICA (f) methods in training period

Source: Research findings

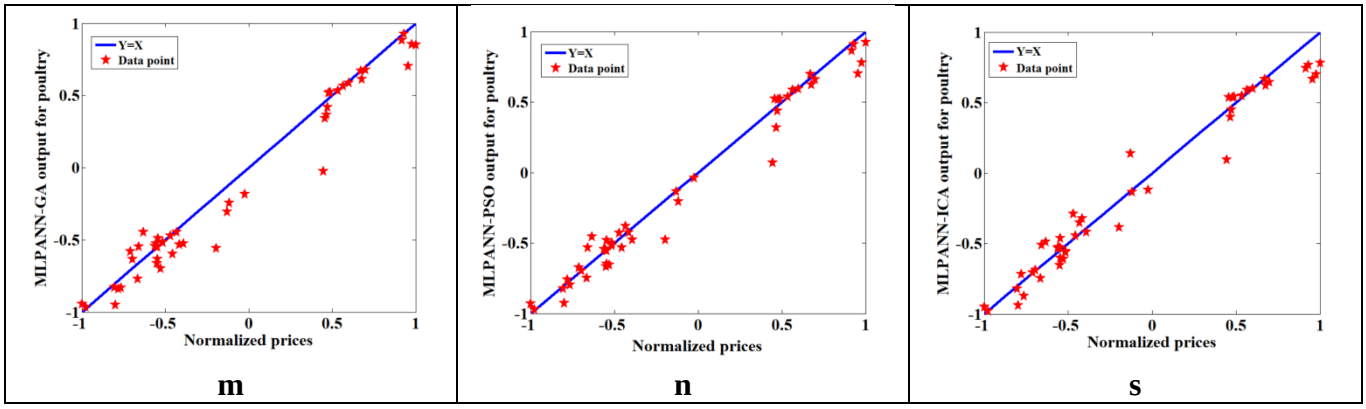
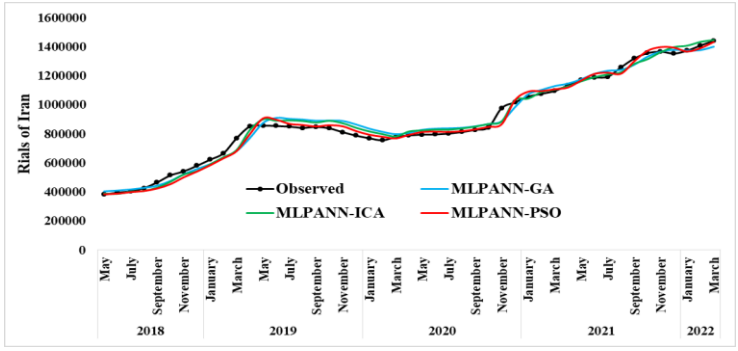


Figure 8- The performance of predicted prices of chicken versus the observed real prices by MLPANN-GA (m), MLPANN-PSO (n) and MLPANN-ICA (s) methods in training period

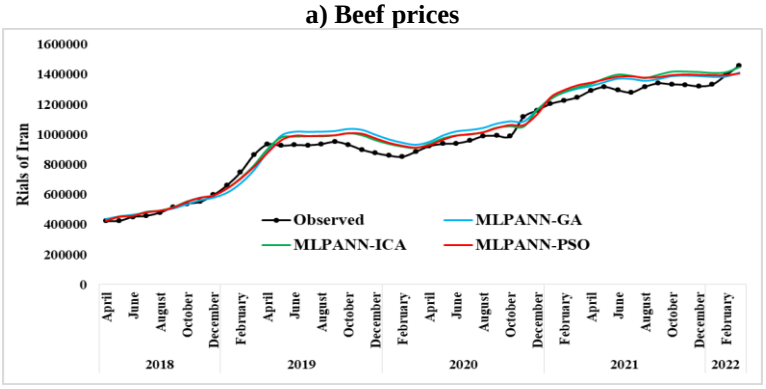
Source: Research findings

The implementation and accuracy of each hybrid methods were evaluated based on the statistical index of Root Mean Square Error (RMSE). This statistical index is indicated in Table 3. Generally, the results of Fig. 9 and Table 3 indicate all three methods provide fitting estimates for the price of beef, lamb and chicken. Also, it can be seen for beef, based on statistical index of RMSE, the MLPANN-ICA method has the best accuracy in forecasting

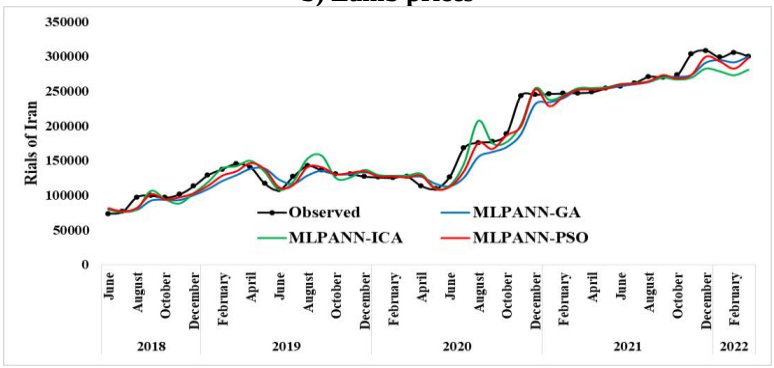
prices compared with MLPANN-PSO and MLPANN-GA methods. In overall, the use of a type of three these hybrid methods cannot be appropriate to forecast agricultural commodities price, therefore usage of combination method can be suitable.



a) Beef prices



b) Lamb prices



c) Chicken prices

Figure 9- The results of observed and forecasted values of MLPANN-GA, MLPANN-PSO and MLPANN-ICA methods for prices of beef, lamb and chicken in test period.

Source: Research findings

Table 3- The results of accuracy comparison between each hybrid methods using of statistical index of RMSE

Commodity	Method	RMSE
Beef	MLPANN-GA	41410.6
	MLPANN-PSO	35353.6
	MLPANN-ICA	34022.5
Lamb	MLPANN-GA	64452
	MLPANN-PSO	56211.7
	MLPANN-ICA	56065.3
Chicken	MLPANN-GA	15336
	MLPANN-PSO	14525.6
	MLPANN-ICA	12496.1

Source: Research findings

The forecasting results of proposed combination methods

In this section, the empirical performance of the combination methods is examined using the testing data set. In fact, combination methods of prices of beef, lamb and chicken for three hybrid methods are analyzed. Used combination methods in this study contain simple averaging method, discounted method and shrinkage method. Simple averaging method consists of two the mean and median methods. Discounted method performs for values of .9, 0.95 and 1.0 for discount factor (γ). In shrinkage method, values of 0.25, 0.5, 0.75 and 1.0 is considered for constant parameter k. Thus, all in all, 9 type of combination methods is utilized. The results of these combination methods for forecasting the prices of beef, lamb, and chicken during the test period are visualized in Fig. 10, 11, and 12.

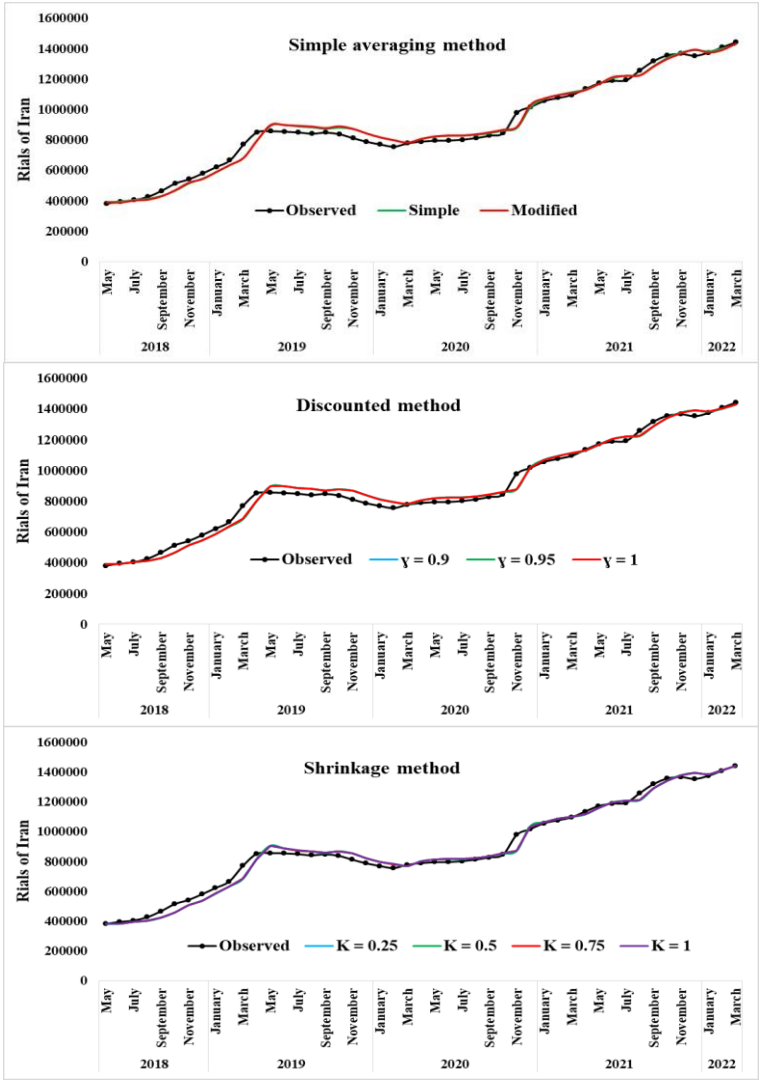


Figure 10- Final forecasted values for beef price by three combination methods
Source: Research findings

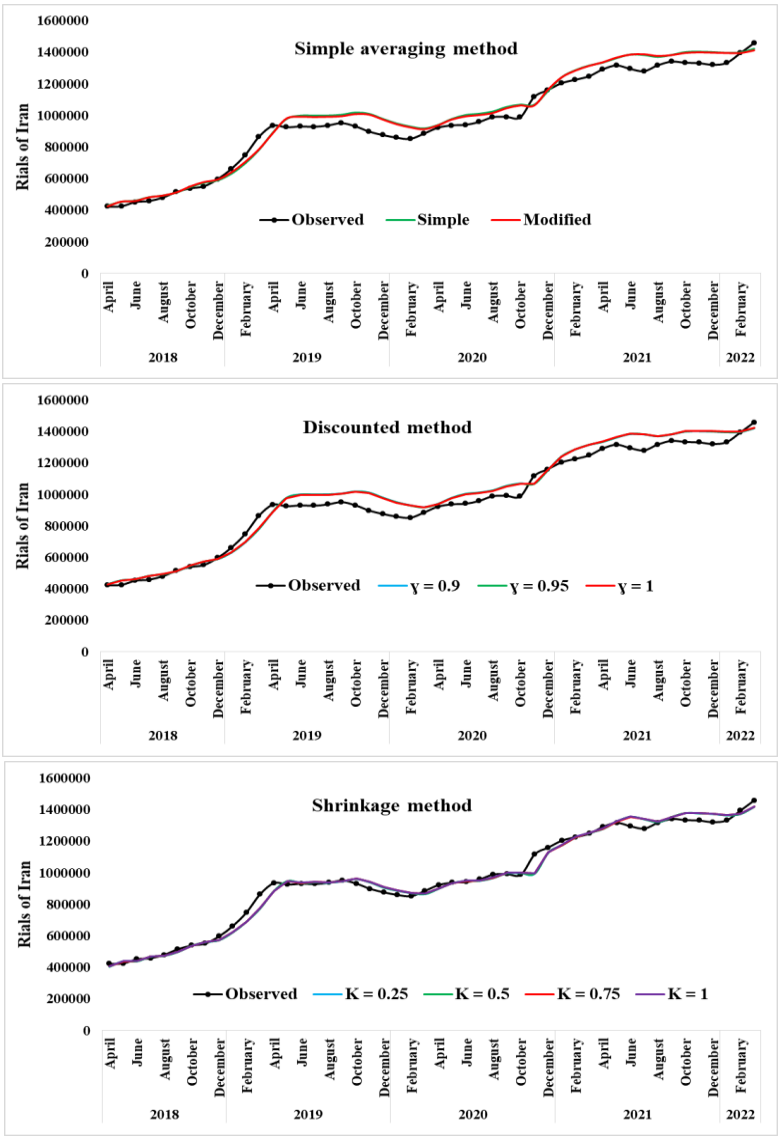


Figure 11- Final forecasted values for lamb prices by three combination methods
Source: Research findings

Additionally, Table 4 provides the calculated values of the root mean square error (RMSE) statistical index for the three combination methods. This statistical index helps assess the accuracy and performance of the combination methods in forecasting agricultural commodity prices. Upon observing Fig. 10, 11, and 12, it is evident that the curves generated by the three combination methods closely resemble each other. An accuracy comparison of these three combination methods in Table 4 reveals that, based on the lowest RMSE values, the shrinkage method with K = 0.25 emerges as the most effective combination method for forecasting beef, lamb, and chicken prices. In summary, the shrinkage method outperforms both the simple averaging and discounted methods when it comes to forecasting meat prices

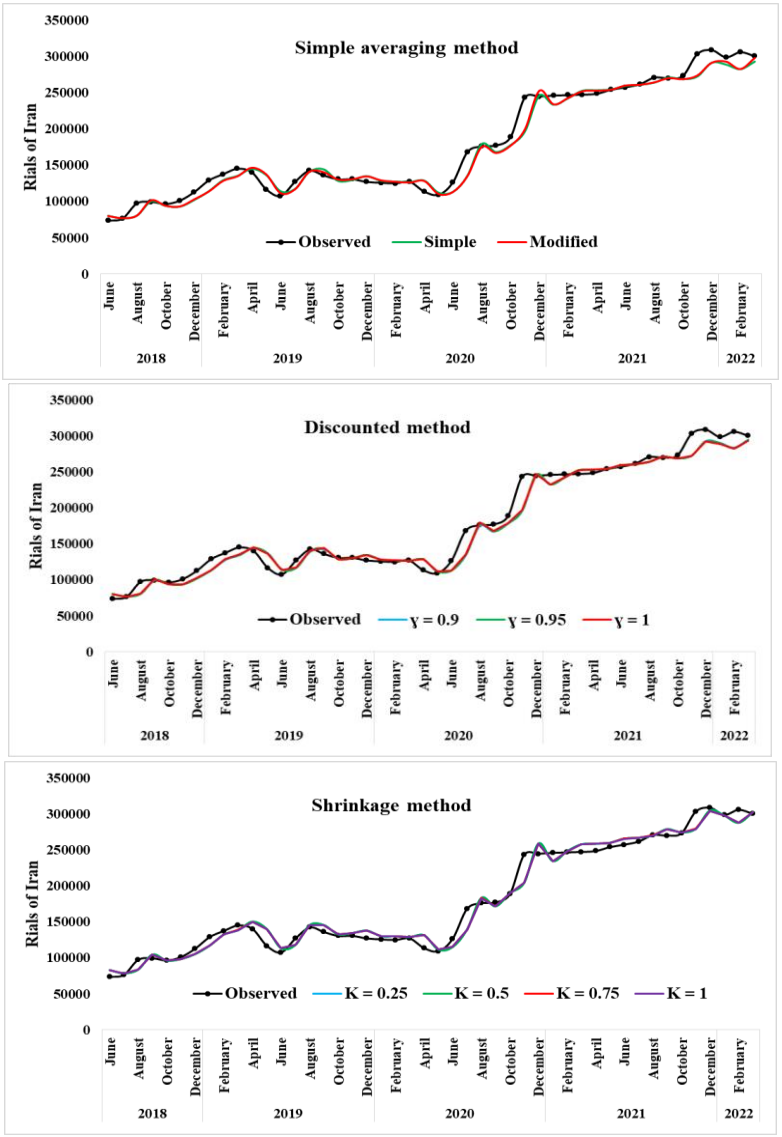


Figure 12- Final forecasted values for chicken prices by three combination methods
Source: Research findings

Table 4- The statistical index of RMSE for three combination methods for beef, lamb and chicken prices

Method	Beef	Lamb	Chicken
Simple averaging: The mean method	34673.9	57937.4	13007.6
Simple averaging: The median method	36393.6	55946.1	12778.9
Discounted method:γ = 0.9	34275.7	58363.2	13038.2
Discounted method :γ = 0.95	34198.6	57942.8	12943.9
Discounted method :γ = 1.0	34168.4	57504.0	12892.5
Shrinkage method:K = 0.25	32527.6	34909.5	11622.1
Shrinkage method:K = 0.5	32529.5	34935.0	11623.4
Shrinkage method:K = 0.75	32532.8	34977.5	11625.7
Shrinkage method:K = 1.0	32537.3	35036.9	11628.8

Source: Research findings

The comparison of results of the proposed combined methods with hybrid methods

To achieve accurate results, the forecasting ability of the combined methods was compared with three hybrid methods. In the more accurate term, the forecasting accurate and ability of

three combination methods were compared with each MLPANN-GA, MLPANN-PSO and MLPANN-ICA methods. The results of this comparison are displayed in Fig. 13, 14 and 15; and Table 5. In Fig. 13, 14 and 15, the scattering plot of the best combination method is mapped versus the plot of three hybrid methods. Also, based on the statistical index of RMSE, the forecasting ability of all combination and hybrid methods were ranked in Table 5.

From Fig. 13, 14 and 15, it can be seen that the curves of combination methods were closer to the curve of actual data. That demonstrated that the combined methods outperformed the other hybrid methods.

The results presented in Table 5 reveal that only four of the shrinkage methods exhibit superior accuracy and forecasting capability across all hybrid methods when it comes to predicting prices for beef, lamb, and chicken, as indicated by the RMSE statistical index. Additionally, the ranking of forecasting accuracy for the MLPANN-ICA method surpasses that of the combined methods of simple averaging and discounted methods for beef and chicken prices, while the Simple Averaging (median) method outperforms for lamb prices. Furthermore, in the case of beef and chicken prices, the forecasting performance of two combination methods, simple averaging and discounted methods, exceeds that of the individual methods MLPANN-PSO and MLPANN-GA methods. Finally, MLPANN-GA method has the lowest rank between all the forecasting methods that are used to forecast prices of beef, lamb and chicken. On overall, the new proposed combined method has lower RMSE into MLPANN-GA, MLPANN-PSO and MLPANN-ICA methods. In a nutshell, the aforementioned comparison results confirm that the proposed combined method outperformed the other three hybrid methods as individual methods.

The review of forecasting studies; such as Wihartiko *et al.* (2021), Raflesia *et al.* (2021), Wang *et al.* (2018), Das and Padhy (2015) and Xiong *et al.* (2015); demonstrate that combination and hybrid methods have better performance than traditional methods and the types of ANN models. The comparison of the present paper with the above studies shows that the results of the present paper is consistent with the results of the aforementioned studies regarding the increase in forecasting accuracy when using combined or hybrid models.

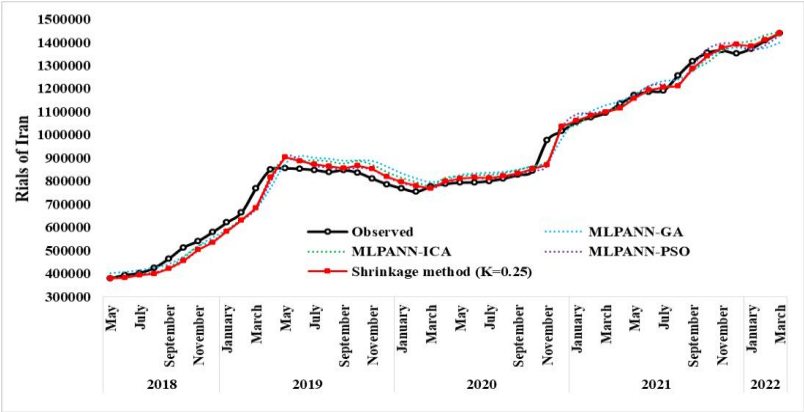


Figure 13- The comparison of the forecasting ability of shrinkage method with three hybrid methods for beef prices

Source: Research findings

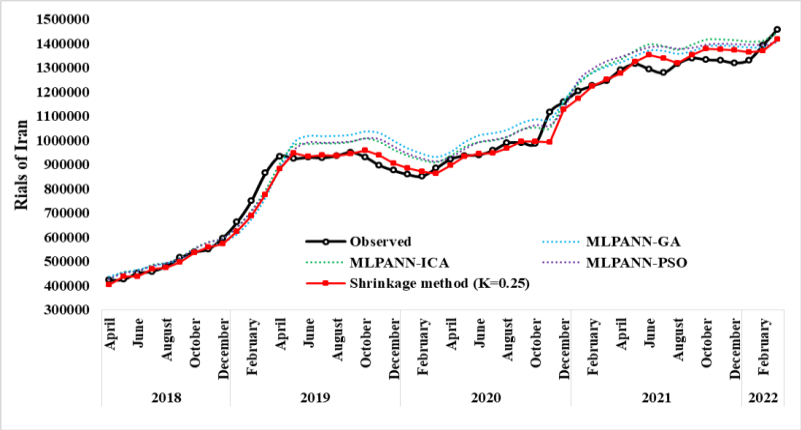


Figure 14- The comparison of the forecasting ability of shrinkage method with three hybrid methods for lamb prices

Source: Research findings

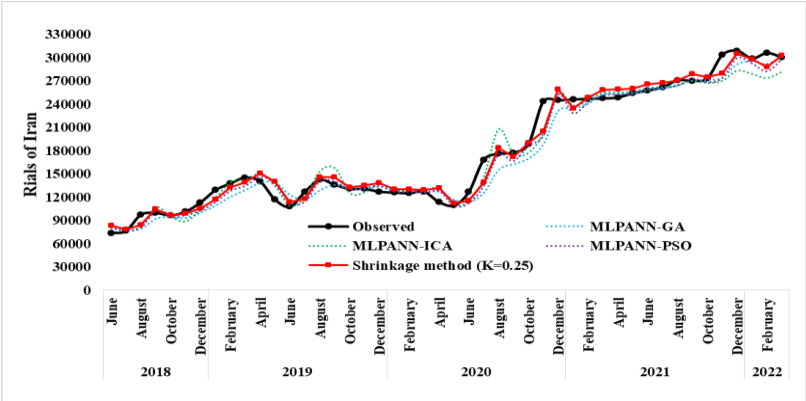


Figure 15- The comparison of the forecasting ability of shrinkage method with three hybrid methods for chicken prices

Source: Research findings

Table 5- Ranking the forecasting ability of combination and three hybrid methods for prices of beef, lamb and chicken

	Method	Beef	Lamb	Chicken
Combination methods	Simple averaging: The mean method	9	9	9
	Simple averaging: The median method	11	5	6
	Discounted method:γ = 0.9	8	11	10
	Discounted method :γ = 0.95	7	10	8
	Discounted method :γ = 1.0	6	8	7
	Shrinkage method:K = 0.25	1	1	1
	Shrinkage method:K = 0.5	2	2	2
	Shrinkage method:K = 0.75	3	3	3
	Shrinkage method:K = 1.0	4	4	4
Hybrid methods	MLPANN-GA	12	12	12
	MLPANN-PSO	10	7	11
	MLPANN-ICA	5	6	5

Source: Research findings

Conclusion

In recent years, economic researchers have increasingly focused on forecasting techniques for agricultural commodity prices, aiming to achieve high accuracy and effectiveness. Effective forecasting methods are instrumental in mitigating price risks and fluctuations. This study sought to evaluate the efficacy of a newly

proposed combined method for modeling the prices of agricultural commodities, specifically meat types. In this research, various hybrid and combination methods were employed. The study introduced a novel combined-hybrid method comprising six distinct approaches: three hybrid methods functioning as individual models and three strategies for combining these individual methods. Three hybrid methods included MLPNN-GA, MLPNN-PSO and MLPNN-ICA, and three approaches consisted of simple averaging, discounted and shrinkage methods. In fact, in this new method, three different approaches were effectively used to combine the forecasting outputs of MLPANN-GA, MLPANN-PSO and MLPANN-ICA methods together. The combined method can improve hybrid methods' forecasting accuracy and incorporate in their output. Also, because of the combination of the three hybrid methods, the new combined method can effectively forecast prices. The results obtained from three hybrid methods for forecasting the prices of beef, lamb and chicken in Iran show that all three methods provide fitting estimates for prices of beef, lamb and chicken. Also, based on the statistical index of RMSE, the MLPANN-ICA method has the best performance in forecasting prices of beef, lamb and chicken. In overall, the usage of a type of three these hybrid methods cannot be appropriate to forecast agricultural commodities price, therefore usage of combination method can be suitable. The outputs of three combination approach indicated that shrinkage method (with K=0.25) has the highest forecasting accuracy for forecasting prices of beef, lamb and chicken. Finally, by using the same experimental data, the performance of the proposed method was compared with other three hybrid methods. Based on RMSE statistical measure, for beef, lamb and chicken, shrinkage method has higher rank into three hybrid method in forecasting prices. The proposed method has demonstrated its superiority over the other three hybrid approaches. This method exhibits versatility, making it suitable for various cases involving different variables, without necessitating complex adjustments to the combined model. Another noteworthy advantage of this novel combined method is its ability to assign weight coefficients to each individual hybrid method through the utilization of the three aforementioned approaches. However, it is important to acknowledge a significant limitation of this study, which is the scarcity of time series data pertaining to agricultural commodity prices in Iran. With access to a more extensive dataset encompassing a broader range of price data, the results obtained from the novel proposed combination method could potentially be further refined and rendered more accurate.

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جلد ۳۷ شماره ۲، تابستان ۱۴۰۲، ص. ۲۰۲-۱۷۷

ارائه یک مدل ترکیبی انعطاف‌پذیر برای پیش‌بینی قیمت محصولات کشاورزی؛ مطالعه موردی بازار گوشت ایران

رضا حیدری[1*]

تاریخ دریافت: ۱۴۰۲/۰۲/۰۵

تاریخ بازنگری۱۴۰۲/۰۴/۲۶

تاریخ پذیرش: ۱۴۰۲/۰۴/۲۶

چکیده

موضوع قیمت یک عامل کلیدی در فعالیت مالی و تجاری مرتبط با بخش کشاورزی است، به گونه‌ای که همواره فعالان بخش کشاورزی در معرض ریسک‌های ناشی از نوسان قیمت محصولات کشاورزی قرار دارند. این مسئله نه تنها منجر به تصمیم‌گیری نادرست در زمینه تولید بهینه محصولات در سال جاری می‌شود، بلکه می‌تواند اجرای تعهدهای مالی آنان را در سال‌های آتی با خطر روبه‌رو سازد. در سال‌های اخیر، نوسانات قیمت محصولات کشاورزی در ایران افزایش یافته است و لذا پیش‌بینی دقیق تغییرات قیمت ضروری به نظر می‌رسد. در مطالعه حاضر، یک رویکرد ترکیبی انعطاف‌پذیر در پیش‌بینی قیمت ماهیانه گوشت گاو، گوشت گوسفند و مرغ از آوریل ۲۰۰۱ تا مارس ۲۰۲۱ ارائه شده است. در این روش جدید، سه روش ترکیب انفرادی مختلف شامل روش میانگین‌گیری، روش تنزیل شده و روش انقباض برای ترکیب خروجی‌های پیش‌بینی مربوط به سه مدل ترکیبی متشکل از شبکه عصبی پرسپترون (MLPANN) و الگوریتم‌های تکاملی (الگوریتم ژنتیک GA، الگوریتم ازدحام ذرات PSO و الگوریتم رقابت استعماری ICA) مورد استفاده قرار گرفتند. نتایج حاصل از این مطالعه نشان داد که بر اساس شاخص آماری RMSE، مدل ترکیبی پرسپترون- الگوریتم رقابت استعماری (MLPANN-GA) و روش انفرادی انقباضی با (K=0.25) دارای بالاترین دقت در پیش‌بینی قیمت گوشت گاو، گوسفند و مرغ است. همچنین عملکرد مدل پیشنهادی از اجزای آن (مدل‌های ترکیبی) بهتر است. روش پیشنهادی برای پیش‌بینی از نظر نوع محصول یا جایگزینی اجزای تشکیل‌دهنده دارای انعطاف‌پذیری است.

واژه‌های کلیدی: پیش‌بینی، قیمت محصولات کشاورزی، گوشت، مدل هیبریدی

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DOI: 10.22067/jead.2023.82122.1187

Journal of Agricultural Economics & Development

Homepage: https://jead.um.ac.ir

Full Research Paper
Vol. 37, No. 2, Summer 2023, p. 203-215

Effect of Quality and Packaging on the Price of Edible Sunflower Oil

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Received: 19-06-2023	**How to cite this article:**
Revised: 06-08-2023	Chizari, A.H., & Dehghani, M. (2023). Investigating the effect of quality and packaging on the price of edible sunflower oil. *Journal of Agricultural Economics & Development, 37*(2), 203-215. https://doi.org/10.22067/jead.2023.83025.1199
Accepted: 16-08-2023	
Available Online: 16-08-2023	

Abstract

The prices accepted by consumers in the market are influenced by the characteristics of the goods, based on consumer behavior. Each of these features contributes to the price agreed upon by both consumers and suppliers. The packaging of a product plays a crucial role in attracting consumers and protecting the product from damage. High-quality and visually appealing packaging can create a positive perception among consumers, potentially resulting in a higher price point. Additionally, specialized packaging techniques designed to preserve freshness and extend the shelf life of oil can also impact the price. This study investigates the impact of quality and packaging on the price of sunflower oil in Iran. The primary objective was accomplished using the hedonic pricing method. Given the qualitative and ordinal nature of the dependent variable, the ordinal logit model was employed. The sample size was determined through a two-stage cluster sampling approach, which involved collecting 350 questionnaires from consumers in Tehran city. Statistical analysis was conducted using Shazam and Stata software. Numerous factors influence the consumption of sunflower oil at various levels. However, in general, factors such as increasing age, higher income levels, the presence of diseases, and dietary considerations contribute to a decrease in its consumption. On the other hand, factors like improving product quality, enhancing the quality of oil packaging, increasing consumer loyalty towards edible oil, and rising online sales of this product contribute to an increase in its demand.

Keywords: Edible oil, Ordinal logit, Packaging, Quality, Sunflower

Introduction

Per capita oil consumption in Iran stands at 17 kg, whereas the global average is 12.5 kg. Studying the behavior of households in terms of consumption of oils and fats has an important place in predicting the health status of society. Oils and fats provide a significant part of the body's energy, essential fatty acids and fat-soluble vitamins (Kobriti *et al*., 2010).

The significance of oils and fats extends beyond health considerations and also holds substantial commercial importance. This importance has led to significant research investments over an extended period of time (Anis Ahangar, 2016). According to the report from the Vegetable Oil Trade Association in Iran, the country's edible oil requirements are partially met by domestic oil production units, while another portion is acquired through the importation of crude oil. Subsequently, this imported crude oil is refined and packaged within domestic factories before being distributed to the market. It's worth noting that during the transportation of imported crude oil from the port to the factory, there is typically a

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DOI: 10.22067/jead.2023.83025.1199

loss of approximately five percent in production. The amount of edible oil production in the country during the years 2015-2019 has grown from 1.5 million kilograms to more than 2 million kilograms on average increasing by 23%. Fraction of the country's need for vegetable oil is provided through imports. A large part of this import is devoted to sunflower oil. According to the report of the Iranian Vegetable Oil Association, sunflower oil is from Ukraine and Russia. The amount of imports has increased from 1 million kilos to 1.5 million kilos of cream. The country's vegetable oil import has grown by an average of 27% during the years 2015-2019. It should be noted that between one and 1.2 billion dollars of foreign currency is spent annually on the import of edible oil. This issue itself is a reason for paying more attention to the quality and packaging of sunflower oil for good marketing.

The rate of decline in oilseed production in Iran has been -85% over the years. The trend of importing oilseeds in Iran is based on the latest statistics published by the Customs of the Islamic Republic of Iran. The amount of import of oilseeds to the country increased by 315% on average during the years 2010-2016. The per capita consumption of oil in the country is about 22 kilograms on average. The trend of per capita consumption of vegetable oil during the years 2015-2016 has grown by an average of 17% per year. According to the statistics published by the Iranian Vegetable Oil Association, the production of oilseeds in Iran does not meet the domestic demand, and most of the demand for this product is met through imports, which is a reason for paying attention to the production of high-quality and marketable oil. Studying for discovering the needs of edible oil consumers and analyzing the process of their buying behavior in these products and prioritizing the influencing factors such as: (quality and packaging) in this process are one of the main duties of marketing managers. As a result, consumers in the target market who are different from each other in terms of economic and buying behavior such as age, income, taste, education level, etc. to identify, for offering appropriate products or services to that market. In this study the research questions are: From the consumer's point of view, regarding packaging, and quality, considering the qualitative and sequential nature of the dependent variable, how effective is it in the price of sunflower oil? Packaging sunflower oil refers to the process of filling and sealing sunflower oil into containers, such as bottles, cans, or pouches, for distribution and sale. It involves several steps to ensure the oil is safely and securely packaged. Packaging means the construction, installation, and preparation of a container that preserves the health of the container or its contents during the period after production and the stages of transportation, storage, distribution, and final consumption and prevents potential physical and chemical injuries and risks. Slow (Romo *et al*., 2018). Packaging is a container that keeps food, protects it, and differentiates the product, packaging also facilitates transportation, storage, and trade. Packaging plays an important role in attracting attention and influencing consumer purchase decisions. All packaging elements must be combined to attract the attention of the consumer when purchasing the product (Ares and Deliz., 2010). Packaging plays an important role in marketing and encouraging or sometimes even discouraging consumers from buying a product especially in the sales phase or when a consumer wants to choose one of the different brands of a product. Consumers' tendency towards better quality food products, fresher and with easier access has increased more than before. By using new and suitable packaging materials and methods, the packaging industry has played an important role in reducing food waste and producing healthier products. Food packaging has been developed to protect food from heat, light, moisture, oxygen, microorganisms, insects, and dust. In the last few decades, we have witnessed the increase of desirable capabilities such as prolonging the life of food by controlling microbial, enzymatic, and biochemical reactions in the packaging environment by implementing various strategies such as oxygen removal, controlled release of salts, carbon

dioxide oxide and so on (Karimi and Mousavi, 2018). Packaging factors that potentially influence consumer decision-making in product selection fall into two categories, including informational and visual elements (Silayvi and Space, 2004). Food packaging is one of the main ways to protect it during the production-to-consumption chain. Preserving food from any foreign contamination, creating an environment away from the atmosphere, light and foreign microorganisms, and increasing shelf life are considered to be general characteristics of existing packaging (Iran-Manesh, 2017). Packaging dimensions are an important tool to communicate with consumers; In such a way that each of those dimensions has different effects on consumer behavior and plays an important role in consumer attraction. Therefore, paying attention to the effects of packaging on consumer behavior can play a significant role in the success of the company (Sabir Nazaraga and Ebrahimi, 2016).

The most common type of household oil is sunflower liquid oil, and these oils are offered in different volumes. The most important factor for the design of oil packaging is the functional and organic criterion. It is important and ultimately the criterion of convenience and beauty of packaging is important for customers (Mohammadi, 2015). Most of the liquid oils that are used for cooking in the commercial area are in volumes from 650 grams to 17 kilograms, but for home kitchens used from 650 grams to 5 kilograms and are packaged in glass and plastic bottles. Glass bottles for sunflowers and most of the oils that are used for frying and cooking are sold in plastic bottles (Mohammadi, 2015). On average, consumers, use 2 liters of edible oil per month. The monthly cost of household food consumption on average is 19768 thousand rials and they spend on average 100 thousand rials to prepare their cooking oil. The lowest coefficient of variation is related to the variable of age and the highest coefficient of variation is related to the variable of monthly cost of edible oil. Since packaging is one of the important tools in national and international marketing, it has its key role. To strengthen their competitive power in domestic and foreign markets, economic enterprises have been paying attention to the issue of packaging for many years, and they use design, graphics, colors, and the use of appropriate packaging to increase their market share compared to competitors. Good packaging can act as a silent salesperson. The research of big oil companies in the field of marketing and ways to promote sales show that packaging has the greatest effect on attracting customers and selling methods in domestic and foreign markets. The packaging may indicate the condition or even the quality of the product.

From a marketing perspective quality, it can be said that some companies have adopted Total Quality Management (TQM) to design their products, services, and marketing processes. Product quality has a direct impact on customer satisfaction. In the most accurate sense, quality can be defined as "immunity from defects". But most customer-oriented companies define quality beyond this concept. They measure quality in terms of customer satisfaction. Quality is the intersection of customer expectations (Juran, 2003). Preserving the well-being of a society's population falls within the realm of ensuring the safety, health, and quality of food. Food quality encompasses a broad spectrum of requirements, encompassing safety, authenticity, nutritional and sensory attributes, as well as ethical considerations and market demands. (Carlucci *et al*, 2013). It is expected that concerning food industry products, quality is an influencing factor in the price paid by the customer, the amount of product consumption, and consumer loyalty. As in the studies conducted by (Hamidizadeh and Ghamkhavari, 2008; Rezaei Galshepel, 2012), this variable is included in the model. According to the information on Iran's food and agriculture industry website, there are 52 active edible oil production companies in the country. Based on the findings of this research, the 5 main brands of household sunflower edible oil along with their consumption share are shown in Table 1. Table 2 shows the number of sunflower edible oil-producing units in Iran.

Material and Methods

Hedonic pricing method

According to Rosen's formulation, the consumer's utility function based on the characteristics of a product can be written as equation (1-1) and as follows.

$u = u(z, \emptyset(x))$ (1)

where Z is the observable characteristics and X is their effects and unobservable characteristics. The important assumption here is the pseudo-concaveness of utility and the linearity of the relationship between X and Z

$Z = X_{n\times k}\beta_{k\times 1}$ (2)

Table 1- The main brands of edible oil and the consumption share of each

Ladan	Oila	Bahar	Famila	Aftab	Other brands
33.36	93.19	79.14	68.8	9.1	32.18

Source: Arifpour, 1396

Table 2- Sunflower Edible oil production companies along with their brand names

Product brand	Company name	Product brand	Company name
Rana	Zarindasht Sofre	Gol Poune	Golbahar oil products
Xdane	Xdane	Etka	Khorramshahr oil company
Nina	Fariko (Iranian oil products)	Nina	Fars Bazargan
Famila– Oila	cultivation and industry of Golbarg Baharan	Khavardasht	Khavardasht
Samre	Samre food industry	Khorasan cotton and oilseeds	Khorasan cotton and oilseeds
Sobhan	Behpak Industrial Co	Naz Banoo	Khorasan process oil
Dalahu (Nazgol)	Mahidasht Kermanshah Agriculture and Industry Company	Mahak	Zartak Sablan
Product Brand	Company Name	Product Brand	Company Name
Aftab	Margarin	Nab	Nab
Verzhen	Agriculture and industry of Golestan abkar	Pamchal	Noush Azar
Varamin	Etka	Salej	Sea potion
Gol Poune	Processing of Golbahar vegetable oils	Jahan	The world's vegetable oil
Gol Naz	Gol Naz vegetable oil	Narges Shiraz	Shiraz vegetable oil
Salamat	Ardabil vegetable oil production cooperative	Naz	vegetable oil of Naze Isfahan
Ghonche	Northern agriculture and industry	Qezel ozen	Gilan Olive
Zarin	Zarin Company in Nama Sharq	Loye	Loye food industry
Niloufar	Arjan Noveen	Ladan	Behshahr Industrial
Balak	Balak Pharmaceutical and food laboratory	Damon	the product
Almo	Eastern Chirak	Saee	Agriculture and industry of Golestan, Dezful
Maryam	hidden flower	Orkide	Golbahar Sepahan
Zarpash	Fasahati food industry	kolale	Gold Ghazan
Bahar	Bahar oil	Manila	Kerman pistachio alchemists
Entakhab	Entakhab novin vegetable oil	Shad gol	Shadgol
Ghou	Pars vegetable oil	Dastaas	Golshan Orange Cooperative Co
Mahya	Caspian radiation	Meysam	agriculture and industry of Golestan Zayton Alborz
Kokab	Golden Olive Agricultural and Food Production Company	Vioni	Arian, the taste of the Caspian
Sadr	Var Aviz oiling	Produced by Golosh Khorasan grain food industry	Produced by Golosh Khorasan grain food industry

[1] Source: Iran food and agriculture industry website 2018

1- www.foodkeys.com

where X is an n×k matrix that is n<k in the general case. n is the number of goods and K is the number of characteristics. If P is a p×1 vector of the unit price of X. Each iM consumer faces the following budget constraints.

$$Px_i = m_i \quad (3)$$

By maximizing the utility function (1-3) provided according to the budget constraint for the consumer, the final situation is as follows:

$$\lambda^h P_j \geq \sum_{i=1}^{h} \frac{\partial u^h}{\partial z_i} \times \frac{\partial z_i}{\partial x_i} + \sum_{i=1}^{q} \frac{\partial u^h}{\partial \emptyset_i} \times \frac{\partial \emptyset_i}{\partial x_i} \quad (4)$$

where q represents the number of specific works of goods and λ^h is the Lagrange coefficient. By putting formula (2) in formula (4) the following relationship is obtained:

$$P_j \geq \sum_{i=1}^{h} [\frac{1}{\lambda^h} . \frac{\partial u^h}{\partial z_i}] b_{ij} + \sum_{i=1}^{q} [\frac{1}{\lambda^h} . \frac{\partial u^h}{\partial \emptyset_i}] \frac{\partial \emptyset_i}{\partial x_i} \quad (5)$$

The Lagrange coefficient is the marginal utility of money for the h-th consumer. Therefore

$$\left(\frac{1}{\lambda^h}\right)\left(\frac{\partial u^h}{\partial \emptyset_i}\right), (\frac{1}{\lambda^h})(\frac{\partial u^\lambda}{\partial z_i}) \quad (6)$$

Shadow prices are for special features and works and in equilibrium is as follows.

$$P_j = \sum_{i=1}^{n} P_{zi} b_{ij} + \sum_{i=1}^{q} P\emptyset_i \frac{\partial \emptyset_i}{\partial x_i} \qquad j1, \ldots., k \quad (7)$$

The equation (7) holds when consumers consume the goods or are about to consume them. As long as the above assumptions are the basis of the Lancaster formula there is a linear relationship between the characteristics and the price of goods. Also, the condition of not being able to repack is established, it is possible to choose different combinations of A to achieve experimental and practical goals between different goods, and the linear form is an acceptable form for the hedonic model. Another important issue in hedonic studies is choosing the appropriate functional form. Researchers in this field use criteria such as goodness of fit, coefficient of determination, and standard deviation of regression. According to the collected data and good model fit criteria, the functional form used in this research is as follows:

$$\ln P_i = b_0 + b_1 \ln x_1 + b_2 \ln x_2 + b_3 \ln x_3 + \cdots + b_n \ln x_n + \varepsilon \quad (8)$$

. In this model, P_i is the price of each liter of edible oil, x_n, x_2, x_1, the characteristics related to the quality and packaging of the edible oil, such as clear color, pleasant smell, high smoke point, pleasant taste, appropriate weight, maintaining the quality of the product. Having food information labels makes it easy to open the door, etc. ε is also an error.

Ordinal logit model

As mentioned above, models with answers to more than two items are divided into sequential and non-sequential. Therefore, in this study, due to the nature of the ordinal selection of the tendency to consume edible oil and loyalty to the edible oil brand, ordinal logit was used, which is one of the most complete models for estimation in such research and can divide and separate the dependent variable under study into There are different classes. In this way, the dependent variable is subjected to a series of assumptions and according to the different specified classes, it assigns values to itself. In this study, the effect of the explanatory variables of education, age, income, marital status, etc. on the consumption of edible oils under study is investigated and determined. The ordinal logit model is based on a continuous latent variable, which is in the form of relation (10-3) (Judge, 1988).

$$y_i^* = \beta' x_i + \varepsilon_i \qquad -\infty < y_i^* < +\infty \quad (9)$$

In this relation, y_i^* people's propensity to consume, β_I is the vector of parameters that must be estimated, $x_i$is the observed vector of the non-random explanatory variable that shows the characteristic of the ith person, ε_i except for the disturbance that is logistic distributed in the ordinal logit Is. Since y_i^* is a latent variable, standard regression techniques do not apply to sample size estimation. If $y_i$is considered as a discrete and observable variable that shows different levels of people's willingness to consume, the relationship between the hidden variable y_i^* and the observed variable y_i from the ordinal logit model is obtained as follows (Green, 2005).

$$y_i = \begin{cases} 0, & -\infty \le y_i^* < \mu_1 \\ 1, & \mu_1 \le y_i^* < \mu_2 \\ 2, & \mu_2 \le y_i^* < \mu_3 \\ . & \\ . & \\ . & \\ j, & \mu_{j-1} \le y_i^* < +\infty \end{cases} \quad i = 1, \dots, n \qquad (10)$$

In this part, n is the value of the sample size, μ_j are the thresholds that define the discretely observed responses, which are estimated by β, and these classes show the same percentage of a tendency to consume edible oils. Give also, the values in the y classification are completely conventional. In this case, the respondents in the questionnaire are faced with a question that asks them to choose their desired y_i^* which depends on the measurable factors x and immeasurable ε, from among the given options. The above model is estimated using the maximum right-exponential method and the desired probabilities are obtained using the equation (10):

$$Pr(y_i = j) = Pr(y_i \ge \mu_{j-1}) = Pr(\varepsilon_i \ge \mu_{j-1} - \beta' x_i) = F(\beta' x_i - \mu_{j-1}) \quad (11)$$

In this relation, F is the cumulative distribution function (CDF) for ε and as can be imagined, its functional form can be determined as logit or probit. In expressing cumulative probability, the ordinal logit model estimates the probability of person i at level j or below (1,...,j-1). It should be noted that the response groups in the ordinal logit model are placed in order. The ordinal logit model is corrected in the form of the equation.

Results and Discussion

To determine the effective factors in the consumption of sunflower oil and to determine the effect of each of the variables, the generalized ordinal logit model was estimated. In this model, the effect of market variables and demographic characteristics of people as explanatory variables on the amount of sunflower oil consumption is measured as a dependent variable. The demographic characteristics of the consumer are gender, age, marital status, education level, number of family members, the effect of disease and diet on the sunflower oil, monthly income, and monthly oil consumption. Also, there are seven marketing variables such as; brand loyalty, price of sunflower oil, quality of sunflower, packaging, advertising, abundance in the market, and online purchase of oil. The correlation coefficients between explanatory variables (independent variable) were tested, and the results showed that there is no high correlation between any of the studied variables.

It should be noted that the classification of consumers in different consumption groups is based on their responses to the questionnaire question (How much sunflower oil do you consume?) and since the answer to this question is in the form of a Likert Scale, therefore consumers have also been made on the same basis based on the frequency of different groups of respondents in the consumption of sunflower oil. According to the results, 47 percent of consumers use sunflower oil in very small amounts, 25 percent of consumers use this oil in a medium amount, and 28 percent of consumers use this oil in large amounts.

Table 3- Frequency of three groups of sunflower oil consumption

Row	Group	Frequency (number)	Frequency (percentage)
1	very little	167	47
2	medium	86	25
3	Much	97	28

Source: Source: Research finding

Table 4- Shows the estimation results of the ordinal logit model

Variable	Coefficient	Significance level	Standard error
Gender	-.604	0.001	.184
Age	-.030	0.002	.009
Marital status	.238	0.279	.220
Education	.144	0.006	.052
the number of family members	-.100	0.130	.066
Effect of disease and diet	.193	0.011	.076
Income	-.107	0.002	.034
Quantity of consumption	.124	0.024	.054
Brand loyalty	.356	0.007	.131
The price of edible oil	.159	0.077	.090
Edible oil quality	.606	0.000	.145
Packaging	-.136	0.207	.108
Advertising	-.172	0.109	.107
Abundance in the market	.181	0.061	.096
Buy oil online	1.024	0.001	.303
The first threshold	2.048		.851
The second threshold	3.453		.862
R^2 = .104 Prob>chi2= 0.000 Loog Likelihood = -599.747			

Source: Research finding

In the estimation of the ordinal logit model, before the results of the model are examined, it is necessary to examine the regression test of parallel lines. The test of parallel regressions evaluates the reasonableness of the theorem of equality of parameters for all groups.

To put it differently, if the null hypothesis of this test, which posits that the coefficients are identical for all groups, is accepted, it suggests that the parameters of the situation are consistent across all response groups. Table 5 presents the outcomes of the parallel regression test. The results show that based on the value of Brent's statistic (80.13) and the significance level (0.00), the null hypothesis of the test, that is, the assumption of parallel regressions, has been violated. This shows that the estimated parameters are not the same for different groups. Therefore, the generalized ordinal logit model is a proper estimation.

Table 5- Parallel regression test results - sunflower oil Brent test

Statistics	The coefficient quantity	The significance level
Wolfe Gould	61.37	0.000
Brant	80.13	0.000
Score	77.68	0.000
likelihood ratio	80.37	0.000
Wald	83.27	0.000

Source: Source: Research finding

In estimating the generalized ordinal logit model, the third group (the group with high consumption of sunflower oil) is considered the base group. The estimation results of the generalized ordinal logit model are shown in Table 6. The value of the Chi-2 statistic shows that the whole regression is significant. The value of R2 is also 15 percent, which is suitable

for models such as ordinal logit. In general, coefficients are not interpreted in these models, only their sign is used in moving to a higher group of consumption. For example, the gender variable in the second group has a coefficient equal to -0.897, which is significant at the one percent level. This means that assuming other conditions are constant, the probability of men being in the heavy consumption group decreases. The age variable in the first group is equal to -0.058 and is significant at the level of one percent. This means that, with increasing the age of consumers, the probability of consumers being placed in the average consumption group decreases. This could be attributed to the fact that as consumers age, their concern for their health and the risk of developing various diseases, including cardiovascular conditions, tends to rise. Consequently, older consumers may opt to use less oil as a way to preserve their health. The coefficient of the marital Stata variable for the first group is equal to 0.839 and is significant at the five percent level. This means that if consumers get married, the probability of them being in the middle consumption group increases. The number of consumers in the family has a coefficient of 0.191, which is significant at the five percent level in groups one and two. Therefore, it can be said that if other conditions are constant, with increase in the number of consumer household members in the low consumption group, the probability of people being placed in the medium consumption group increases, and also in the medium consumption group, with the increase in the number of household members, if other conditions are constant, the probability of consumers being placed in the middle consumption group increases. The consumption group will increase a lot. This issue is caused by the increase in the amount of consumption due to the increase in the number of family members.

Table 6- The results of the estimation of the generalized ordinal logit probabilities model of sunflower oil

Variable	The coefficient quantity	The significance level	The coefficient quantity	The significance level
Gender	-0.293	0.230	-0.897	0.000
Age	0.058	0.000	-0.003	0.752
Marital status	0.839	0.002	-0.077	0.750
Education	-0.043	0.535	-0.043	0.535
The number of family Members	0.191	0.012	0.191	0.012
Effect of disease and diet	-0.526	0.002	-0.526	0.002
Income	-0.164	0.000	-0.050	0.174
Quantity of consumption	0.098	0.061	0.098	0.061
Brand loyalty	0.314	0.010	0.341	0.010
The price of edible oil	0.105	0.257	0.105	0.257
Edible oil quality	0.206	0.308	0.105	0.257
Packaging	0.077	527.	-0.292	0.008
Advertising	-0.217	048.	-0.217	0.048
Abundance in the market	0.049	0.658	0.315	0.002
Buy oil online	1.069	0.000	1.069	0.000
R^2 = .154 LR chi2=159.045 Prob>chi2= 0.000 Loog Likelihood = -566.547				

Source: Research finding

Due to the similarity of the interpretation of the coefficients and to avoid repetition as well as more use of the interpretation of the final effect in logit models, we ignore the interpretation of other variables and proceed to the interpretation of the final effect. For this purpose, the final effects were calculated for each of the household groups with different levels of sunflower oil consumption, and the results are presented in Table 7.

Table 7 shows the results of estimating the final effect of independent variables in all consumption groups. Based on the result, it can be said that with the stability of other conditions, at the average consumption level, the probability of men being placed at the higher consumption level increases by 0.171 units, while in the high consumption group, this probability decreases by 0.222 units.

With one-unit increase in the age of consumers, in a low consumption group, the probability of being in a higher consumption group increases by 0.012 units, while at an average consumption level, this probability decreases by 0.009 units, which can be due to paying more attention to diet and reducing oil consumption to maintain health and prevent disease in older age. With other variables being constant, at low and high consumption groups, the probability of married people being placed in the higher consumption group decreased by 0.147 and 0.019 units, respectively, while the probability of the married middle consumer's group being placed at higher levels was 0.166 unit increases. With the increase in the number of family members, the probability of low and medium-group consumers being in the higher consumption group decreased by 0.033 and 0.013 units, respectively, while in the high consumption group, the probability of people being in the higher consumption group was 0.047 units will increase.

In large families where monthly sunflower oil consumption is higher, there is a preference for using more oil, especially if it has a lower price compared to other edible oils. Additionally, the influence of health concerns and dietary considerations on the choice of oil increases the likelihood of low and medium-level consumers being categorized into higher consumption groups by 0.072 and 0.038 units, respectively. Conversely, the probability of high-level consumers being classified into the higher consumption group decreases by 0.120 units. An increase in people's income, assuming that other conditions are constant, increases the probability of low-level consumers in higher consumption levels by 092/0 units, while this probability for medium and high-level consumers is 0.044 units and 0.174, respectively unit decreases, which can be concluded that as people's income increases, their desire to use healthier vegetable oils increases. With an increase in the amount of sunflower edible oil consumption, the probability of people with low and medium levels being placed in higher levels decreases by 0.017 and 0.007 units respectively, while the probability of high-level consumers being placed in higher levels is 0.024 unit increases. It can be said that for consumers who use sunflower oil in large quantities, if their consumption increases, the probability that they will replace sunflower oil with other edible oils is very low, but this probability is low for the average consumption group and is much higher. As the level of loyalty to the sunflower edible oil brand increases, the probability of consumers in the low and medium consumption groups being placed in the higher groups is 0.060 and 0.024 units, respectively, and the probability of high-level consumers being placed in higher consumption levels is 0.084 unit increases. Therefore, it can be said that loyalty to the brand in the high consumption group will increase the level of consumption. This issue is caused by the recognition and trust of the consumer in the quality, price, and other characteristics of the product.

Table 7- Results of the final effect of the generalized ordinal logit model of sunflower oil

	Consumption level 1		Consumption level 2		Consumption level 3	
Variable	**The coefficient quantity**	**The significance levels**	**The coefficient quantity**	**The significance levels**	**The coefficient quantity**	**The significance levels**
Gender	.051	0.233	171.	0.000	222-.	0.000
Age	.012	0.000	009-.	0.000	003-.	0.752
Marital status	-.0147	0.002	166.	0.001	019-.	0.749
Education	.007	0.537	003.	0.530	010.	0.534
The number of family Members	-.033	0.013	013-.	0.019	047.	0.012
Effect of disease and diet	.092	0.001	038.	0.010	120-.	0.002
Income	.028	0.000	016-.	044.	072-.	0.174
Quantity of consumption	-.017	0.062	007-.	0.074	024.	0.061
Brand loyalty	-.060	0.010	024-.	0.022	084.	0.010
The price of edible oil	-.036	0.310	201.	0.000	237.	0.000
Edible oil quality	-.013	0.526	086.	0.000	072-.	0.008
Packaging	-.038	0.045	015.	0.072	054.	0.049
Advertising	-.008	0.657	069-.	0.000	078.	0.002
Abundance in the market	-.188	0.000	077-.	0.004	265.	0.000

Source: Research finding

According to Table 7, with the increase in the quality of sunflower edible oil, the possibility of people with medium and high consumption groups being placed in higher consumption groups increases by 0.201 and 0.237 units, respectively. This fact indicates the high importance of quality in consumer selection, loyalty, and increase in edible oil consumption. Therefore, it can be said that the production of a high-quality product by oil-producing companies will increase the level of consumption and loyalty to the consumer brand. An increase in packaging quality increases the probability of middle-level consumers being placed in higher levels by 0.086 units, while this probability decreases by 0.072 units for high-level consumersIn conclusion, focusing on packaging improvements and enhancing the design and quality of the product can serve as an effective marketing strategy to attract more consumers to the middle consumption group. However, it's important to note that an increase in the price of sunflower oil, driven by elevated packaging costs, may lead to reduced consumption among the high-consumption group. Consequently, consumers with moderate consumption levels tend to place greater emphasis on the quality of the packaging for their sunflower edible oil, in contrast to those with high consumption levels. Therefore, addressing this aspect and implementing changes and enhancements at a reasonable cost can result in a significant increase in sunflower oil sales volume. An increase in advertisements decreases the probability of low consumer level group consumers being placed in higher levels groups by 0.038 units, and increases the probability of middle and high-level consumers being placed in higher levels groups by 0.015 and 0.054 units, respectively.

As expected, advertisements have positive effects on sunflower oil consumption in medium and high consumer groups. In the medium consumption group, the increase in the variety of the product in the market find reduces the probability of the number of consumers in this group being placed in the higher levels group by 0.069 units, while for consumers who are in the high consumption level group, this

probability increases by 0.078 units. Therefore, the availability of the product in the market and the easier access of consumers to it will increase sales and also increase loyalty to it, which is in line with the results of Arifpour's study (2016). According to the results obtained in Table 7, it can be said that buying sunflower oil online reduces the probability of consumers from the low and medium consumption group being placed in the higher consumption group by 0.188 and 0.077 units, respectively, while this probability factor Placement of high consumption group people in higher consumption levels increases by 0.265 units. It can be concluded that consumers with a high level of oil consumption consider online shopping markets as an easy solution to purchase sunflower products, save time and travel costs, and also reduce costs by benefiting from the discounts offered by online markets.

According to the obtained results, sunflower oil has the highest consumption position compared to other edible oils for several reasons, such as having a lower price than other edible oils, the harmony of taste and smell with the taste of most consumers. Various factors affect the consumption of this sunflower oil at different consumption levels, but in general, factors such as increasing age, increasing level of income and increasing the level of the awareness effect of disease and diet on the type of sunflower cause a decrease in the consumption of this edible oil. Also, other factors such as increasing the level of product quality, increasing the level of quality of oil packaging, increasing the level of consumer loyalty to sunflower edible oil, and increasing the online shopping of this product, increase the demand for sunflower.

Conclusions and Suggestions

According to the obtained results, sunflower oil has the highest consumption position compared to other edible oils for several reasons, such as having a lower price than other edible oils, the harmony of taste and smell with the taste of most consumers, etc. As consumer age increase, their desire to use sunflower oil decreases. Being married causes a decrease in the consumption of this oil at low and high consumption levels group and an increase in consumption at the medium level group. The increase in the number of consumers in the family reduces the consumption of this oil at the low and medium consumption levels groups and increases the consumption at the high consumption level group. The increase in the effect of disease and diet awareness on the type of sunflower oil causes an increase in the consumption of sunflower oil in low and medium consumption levels groups and a decrease in its consumption in the high consumption levels group. An increase in consumer's income causes an increase in consumption at the low consumption level and a decrease in the amount of consumption at the medium and high consumption level. As the level of loyalty to the sunflower edible oil brand increases, there is a decrease in sunflower oil consumption within the low and medium-consumption groups. However, in the high-consumption group, there is an increase in sunflower oil consumption with higher brand loyalty. Increasing the quality of sunflower edible oil increases consumption in the medium and high consumption groups. Improving the packaging of sunflower edible oil leads to an increase in consumption in the medium consumption group and a decrease in consumption in the high consumption level. An increase in advertising causes an increase in consumption at the medium and high consumption levels groups and a decrease in consumption at the low consumption level group. An increase in variety in the market causes a decrease in consumption at the medium level and an increase in consumption at the high consumption level. Buying oil from online marketing will reduce consumption at low and medium consumption levels and increase consumption at high consumption levels.

In general, according to the obtained results, producing high-quality products and presenting them in various packages, conducting extensive advertisements, and increasing product variety supply in the market, especially online markets, can help to increase product sales and attract

loyal customers. Nowadays, with the expansion of the culture of online shopping and the attractiveness of these markets for various reasons such as discounts, free shipping, and the possibility of comparing the quality and price of products in real-time, these markets are very attractive for consumers. Therefore, it can be said that one of the most practical ways to increase market share is to offer products in online markets.

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Journal of Agricultural Economics & Development

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مقاله پژوهشی

جلد ۳۷ شماره ۲، تابستان ۱۴۰۲، ص. ۲۱۵-۲۰۳

بررسی اثر کیفیت و بسته‌بندی بر قیمت روغن خوراکی افتابگردان

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تاریخ دریافت: ۱۴۰۲/۰۳/۲۹

تاریخ بازنگری: ۱۴۰۲/۰۵/۱۵

تاریخ پذیرش: ۱۴۰۲/۰۵/۲۵

چکیده

بر اساس رفتار مصرف‌کنندگان قیمت‌هایی که در بازار مورد پذیرش مصرف‌کننده قرار می‌گیرند ناشی از ویژگی‌های کالاهاست .این ویژگی‌ها هرکدام سهمی در قیمت مورد توافق مصرف‌کننده یا تقاضاکننده و عرضه‌کننده دارد. لذا شناخت دقیق خواسته‌های مصرف‌کننده موجب تولید و عرضه کالای تقاضامحور، کاهش هزینه‌های بازاریابی، نفوذ بیشتر محصول در بین مصرف‌کنندگان و افزایش مطلوبیت مصرف‌کننده و وفاداری او به برند خواهد شد. این مطالعه به بررسی اثر کیفیت و بسته‌بندی بر قیمت روغن خوراکی (آفتابگردان) در شهر تهران به‌عنوان بزرگ‌ترین بازار مصرف روغن خوراکی پرداخته‌است. به‌منظور دست‌یابی به هدف اصلی از روش قیمت‌گذاری هدونیک استفاده شده‌است. سپس به‌منظور تعیین عوامل مؤثر بر مقدار مصرف این روغن‌ها و همچنین تعیین عوامل مؤثر بر وفاداری مصرف‌کننده به برند روغن خوراکی، با توجه به ماهیت کیفی و ترتیبی متغیر وابسته از الگوی لاجیت ترتیبی استفاده شده‌است. تعیین حجم نمونه به روش نمونه‌گیری خوشه‌ای دومرحله‌ای در دسترس از بین کل مصرف‌کنندگان شهر تهران بوده و اطلاعات از جمع‌آوری ۳۵۰ پرسشنامه که توسط مصرف‌کنندگان تکمیل گردیده، به‌دست‌آمده است. الگوهای موردمطالعه به ترتیب با استفاده از نرم‌افزارهای shazam و stata برآورد شد. عوامل مختلفی بر میزان مصرف این روغن در سطوح مختلف مصرف تأثیرگذار می‌باشد .اما به‌طورکلی عواملی مانند افزایش سن، افزایش سطح درآمد و افزایش سطح تأثیر بیماری و رژیم غذایی بر نوع روغن خوراکی موجب کاهش در میزان مصرف این روغن خوراکی می‌شود. همچنین عوامل دیگری مانند افزایش سطح کیفیت محصول، افزایش در سطح کیفیت بسته‌بندی روغن، افزایش سطح وفاداری مصرف‌کننده به روغن خوراکی و افزایش فروش آنلاین این محصول، افزایش سطح تقاضا برای این خوراکی را به همراه دارد.

واژه‌های کلیدی: روغن خوراکی، قیمت‌گذاری هدونیک، لاجیت ترتیبی، وفاداری به برند

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DOI: 10.22067/jead.2023.83025.1199

Journal of Agricultural Economics & Development

Homepage: https://jead.um.ac.ir

Full Research Paper
Vol. 37, No. 2, Summer 2023, p. 217-230

Efficiency and Capacity of Iran's Cropland Products Exports: An Application of Stochastic Frontier Gravity Model

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Received: 16-07-2023	**How to cite this article:**
Revised: 20-08-2023	Aminizadeh, M., & Rafati, M. (2023). Investigating the efficiency and capacity of Iran's cropland products exports: An application of stochastic frontier gravity model. *Journal of Agricultural Economics & Development, 37*(2), 217-230. https://doi.org/10.22067/jead.2023.83459.1202
Accepted: 20-08-2023	
Available Online: 20-08-2023	

Abstract

Iran's agricultural exports have grown significantly in recent years. Cropland products (HS07) have become the second most important group in Iran's agricultural exports over the last years. However, few studies have investigated the export potentials of cropland products. Therefore, this study aims to determine the main factors of Iran's cropland products exports and calculate the export efficiency and potential in the trading partners. For this aim, the stochastic frontier gravity model is estimated based on balanced panel data covering 21 importing countries over the period of 2001 to 2021. The results indicated that economic and physical size of importing countries have positive and significant effect on the exports of Iran's cropland products. In addition, common border between Iran and trading partners and economic sanctions have also positive and significant effect on the cropland products exports, while geographical distance between Iran and importing countries has negatively effects on the exports. The results of export efficiency showed that Iran does not have 100 percent efficiency in any destination market over the period of 2015 to 2021. Iran has an export efficiency of more than 50 percent only in Afghanistan, United Arab Emirates, Canada and Iraq. According to the results, Iran has the highest potential for exports of cropland products in Iraq. Hence, considering the high potentials in neighboring countries and significantly positive effect of common border partners, it is suggested that trading countries with common border like Iraq should be a top priority for the exports of cropland products.

Keywords: Agricultural exports, Trade efficiency, Trade potential

Introduction

The global trade network helps exporting countries adjust their production plans from low-efficiency sectors to high-efficiency sectors by identifying their advantageous production capacities (Isaiah Zayone *et al.*, 2020). Export-based growth is one of the approaches that researchers have always emphasized. In this approach, the analysis of export determinants is examined along with growth, because no export program can be successful without a deep understanding of the economic environment and its influencing factors on export (Atif *et al.*, 2017).

In recent decades, studies have determined the export capacities of countries using different methods. These studies examine various concepts such as measuring the degree of competitiveness (Fertö and Hubbard, 2003; Pawlak and Smutka, 2022), identifying trade determinants (Shepherd and Wilson, 2013; Hejazi *et al.*, 2022), analyzing survival rates in markets (Bojnec and Fertő, 2009; Engemann *et al.*, 2023) and other topics have been discussed. One of the concepts that has recently received

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DOI: 10.22067/jead.2023.83459.1202

serious attention from researchers and policymakers is export efficiency, which shows the export performance of a country in the destination markets. Export efficiency shows the amount of a country's actual exports compared to its maximum export capacity (Doan and Xing, 2018). From the perspective of bilateral trade, trade potential between two countries refers to the maximum amount of trade that can be achieved without any natural or man-made obstacles (Mohammadi *et al.*, 2020). Efficient export potentially improves the efficiency in the allocation of entities between different activities and increases market opportunities and creates jobs and businesses (European Commission, 2010). The performance and efficiency of countries in exporting products to trading partners are different and it is necessary to determine its degrees. Because focusing on determining the degree of export efficiency allows policy makers and planners to identify suitable export markets and minimize the restrictions and obstacles in trade in order to achieve full export potential. Analyzing the efficiency and performance of trade flows of different products is necessary for Iran as a developing country that needs planning and targeting in different economic sectors such as the agricultural sector.

The agricultural sector is considered as one of the most important axes of economic development in many countries of the world. In Iran, due to the existence of climatic diversity and lands prone to agriculture, this sector is one of the dynamic and productive sectors of the economy. Strengthening this sector is necessary in order to ensure food, political, and economic security, as well as reducing food imports and implementing non-oil export expansion policies (Mehrparvar Hosseini *et al.*, 2013; Mortazavi and Mojtahedi, 2016; Aminizadeh *et al.*, 2020). The development of the agricultural sector by paying attention to export capacities will increase the income of farmers and the rural community in the short term, improve the standard of living and well-being, as well as reduce poverty in the medium term and reverse migration from cities to villages in the long term (Hosseini *et al.*, 2018; Ghorbani and Aminizadeh, 2020). For this reason, in recent years, policy makers and decision makers have paid special attention to this sector. For example, in the Law on the Sixth Five-Year Economic, Cultural and Social Development Plan of the Islamic Republic of Iran for 2017-2021, which was approved in 2017, the development of agricultural exports and the strengthening of villages with an export-oriented approach have been emphasized.

In the last 20 years, the amount and share of Iran's agricultural sector's export has increased from the total export. Iran's agricultural exports have increased from $1 billion in 2001 to more than $5 billion in recent years (ITC, 2021). The share of agricultural exports has also increased from 4% in 2001 to about 8% (Fig. 1). It is worth noting that the growth of exports in recent years has not been focused on garden products and dry fruits as Iran's traditional export products, and the export of agricultural products, fishery products and processed and industrial products have grown significantly. Although in the last decade, the export of other products has grown and taken a high share, most of the studies have focused on the export of horticultural products and dry fruits. In recent years, selected cropland products (HS07), have a share of more than 16% of the export of agricultural products. While this share was nearly 6% in the period of 2001-2007.Also, the export amount has increased from about 100 million dollars in 2001 to more than 800 million dollars in 2021. In years like 2018 and 2019, the export amount was more than 1 billion dollars (Fig. 2). A high share of the export of cropland products is to regional trading partners, which creates a higher profit margin due to the reduction of transaction costs, including market search, contract closing, and transportation costs. Therefore, it can be said that these products has a high export potential and it is necessary to pay attention to identifying its various trade dimensions for planning and policy making. Therefore, this study attempts to examine the efficiency of Iran's agricultural products export and the factors affecting its export.

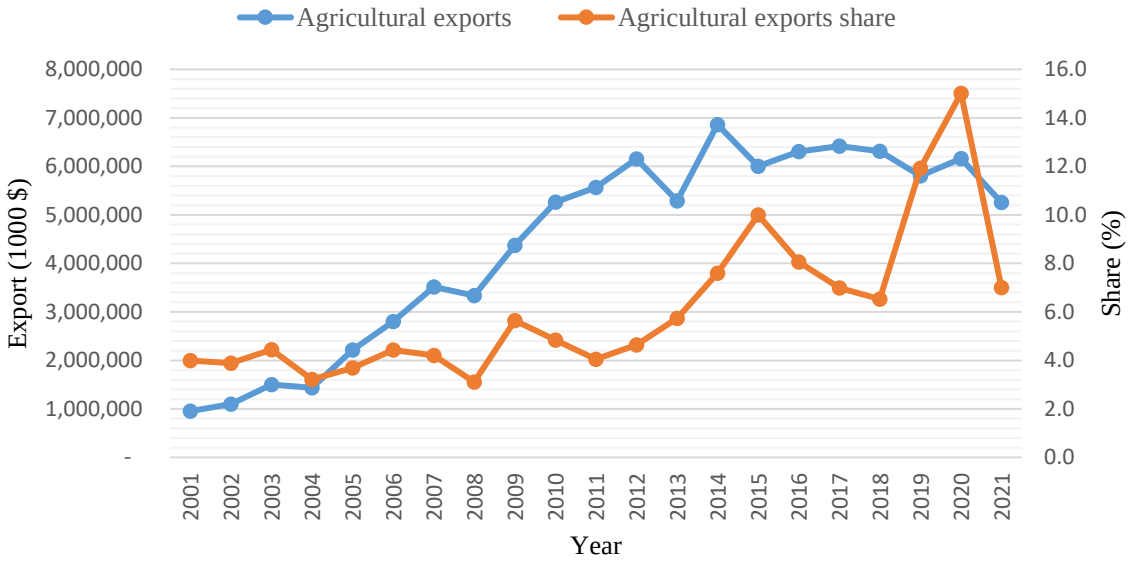

Figure 1- The amount and share of Iran's agricultural exports (2001-2021)
Source: International Trade Center, 2023

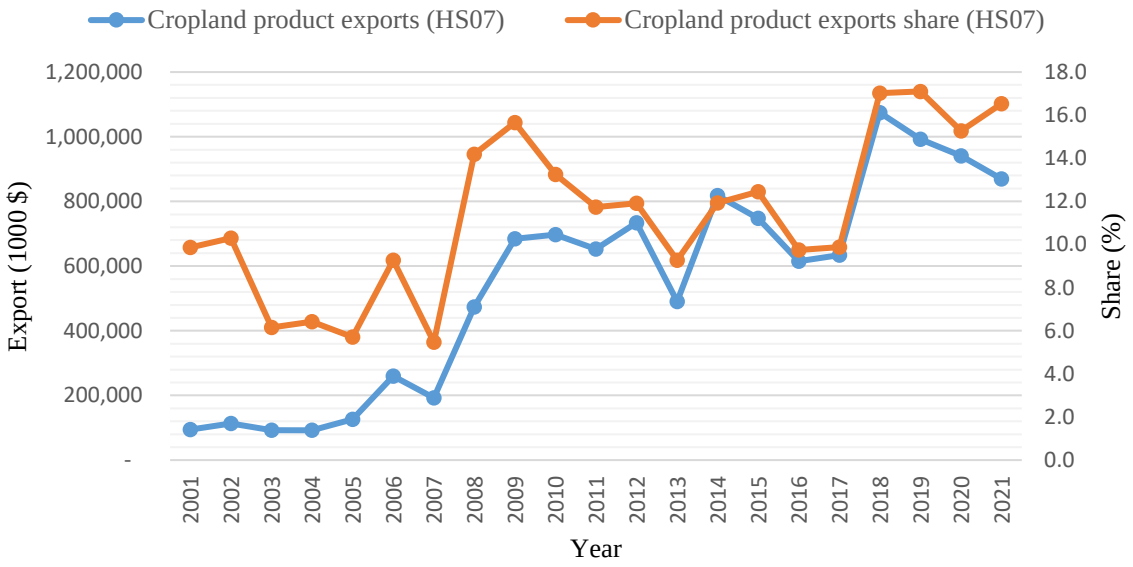

Figure 2- The amount and share of Iran's cropland products exports (HS07) (2001-2021)
Source: International Trade Center, 2023

Determining the efficiency of exports has received serious attention from researchers in recent years. Atif *et al.* (2017) showed that the economic size of the trading partners, regional trade agreements, bilateral exchange rate and common border have positive effects on Pakistan's agricultural exports, while geographical distance and tariff have negative effects on exports. Also, the efficiency results showed that Pakistan has great export potential with neighboring, European and Middle Eastern countries. Mohammadi *et al.* (2020)

showed that the efficiency of Iran's pistachio exports in European countries has been declining, while the export efficiency has been increasing for Asian countries and has reached from 0.412 to 0.567. Hajivand *et al.* (2020) showed that GDP and population have a positive and significant effect, while geographical distance and tariff have a negative and significant effect on Iran's agricultural exports. They also showed that Iran has high potential in destination markets. Abdullahi *et al.* (2021) indicated that the economic size of Nigeria and its trading partners, the population of importers, EU membership, ECO agreement membership, and common border between Nigeria and its partners increase the agricultural exports, while, distance, internal population, exchange rate, language and landlocked have a negative effect on the export of agricultural products. Their findings indicate that there is potential to expand agricultural trade with most of the world's major economies (including China, USA, Brazil, India, Russia, Japan, and EU countries) and Nigeria's neighboring countries. Abdullahi *et al.* (2022) showed that the economic size variable of China and its importing countries and the virtual variables of the countries in the Belt & Road Initiative, the common border and the Chinese language have a positive effect on the flow of China's agricultural exports. On the other hand, the results also show that China's agricultural exports are adversely affected by GDP per capita of China and its trading partners, currency depreciation, distance, and landlocked. According to the findings, on average, China has not used the potential of 51 percent in its agricultural exports. Nguyen (2022) revealed that Vietnam has great potential to increase rice and coffee exports with its main trading partners. They suggested that exports to EU member countries should be given serious consideration. Ahmad Hamidi *et al.* (2022) indicated that Indonesia and Malaysia have great potential to use more than similar countries, namely China, India, Thailand, and USA. They suggested that policymakers of both countries should formulate a new hybrid strategy to maximize palm oil exports to their trading partners. Mohammadi *et al.* (2022) showed that the efficiency of Iran's saffron exports in 2017 is equal to 45 percent. The results revealed that Iran has the highest efficiency in Spain (93 percent) and United Arab Emirates (87 percent), respectively, while the lowest efficiency is in Japan (7 percent) and England (13 percent). Also, the results showed that the export efficiency in Asian markets has increased and reached 0.41 in 2017 from 0.31 in 2001. Tandra and Suroso (2023) found that Importer's GDP, bilateral exchange rate and WTO membership have a positive and significant effect on Indonesia's palm oil exports. However, there are significant and negative effects of geographical distance between Indonesia and trading partners and landlocked countries. In addition, the results show that Indonesia does not have maximum efficiency in any destination market. Xu and Num (2023) indicated that the variables of the economic size of the trading partner and the added value of the agricultural sector and membership in the WTO have positive effects on exports, while distance has negative effect. The efficiency results also show that Vietnam has low efficiency in large markets and its potential is very high. They suggested that the Vietnamese government should focus on designing a policy framework to encourage export companies to invest more in technology, especially for large markets such as USA, Japan, and Korea.

The purpose of this paper is threefold. First, to identify the factors affecting the export of Iran's cropland products to trading partners. Second, to measure the efficiency of Iran's exports in the destination markets and determine the export potential of these markets. Third, to identify the markets with higher levels of profitability by forming the efficiency-potential matrix. The rest of this study is organized as follows. Section 2 provides data and methodology. Section 3 presents the results and discussion. Section 4 concludes some policy recommendations for policy makers and future studies.

Data and Methodology

The gravity model was first used by Tinbergen (1962) in international trade and became a widely used tool for analyzing trade flows (Natale *et al.*, 2015; Assoua *et al.*, 2022; Ha, 2023) and in recent years, it is used in various fields of study such as foreign direct investment (Kahouli and Maktouf, 2015; Badarinza *et al.*, 2022; Okara, 2023) and migration (Manzoor *et al.*, 2021; Arif, 2022). The basic form of the gravity model is defined as equation (1):

$$T_{ijt} = \beta_0 + \beta_i X_{ijt} + \varepsilon_{ijt} \quad (1)$$

where i, j and t represent Iran, importing countries and year, respectively. T_{ijt} and X_{ijt} denote the trade flows and independent variables, respectively. β is regression coefficients and ε_{ijt} is residual error.

Considering the importance of determining the export efficiency degree, many researchers used the traditional gravity model to measure the trade potential between countries (see Nilsson, 2000; Egger, 2002; Ülengin *et al.*, 2015). However, a number of studies such as Anderson and Wincoop (2003) and Armstrong (2007) showed that this method is not effective.

The stochastic frontier gravity model, which is a combination of two widely used methods, the gravity model and the stochastic frontier production function model (Aigner *et al.*, 1977), has well solved the problems of calculating efficiency using the previous method (Xu *et al.*, 2022). This method has been used in recent years in extensive international studies (Kalirajan, 2007; Ravishankar and Stack, 2014; Nasir and Kalirajan, 2016; Atif *et al.*, 2019; Noviyani *et al.*, 2019; Xu *et al.*, 2022; Abdullahi *et al.*, 2022; Ahmad Hamidi *et al.*, 2022; Tandra and Suroso, 2023; Liu and Zhou, 2023). The stochastic frontier gravity model is defined as equation (2):

$$T_{ijt} = \beta_0 + \beta_i X_{ijt} + \upsilon_{ijt} - u_{ijt} \quad (2)$$

where u_{ijt} shows technical efficiency and identifies the extent to which the actual exports level strays from the maximum potential exports .v_{ijt} represents a double-sided error term. Other parameters are defined in equation (1). For export efficiency can be estimated by equation (3) (Battese and Coelli, 1988):

$$E\left[\exp\left(-u_{ij}^{t}\middle|\varepsilon_{ij}^{t}\right)\right] = \left[\frac{1-\phi\left(\sigma_* - \frac{\mu_{*ij}^{t}}{\sigma_*}\right)}{1-\phi\left(-\frac{\mu_{*ij}^{t}}{\sigma_*}\right)}\right]\exp\left(-\mu_{*ij}^{t} + \frac{1}{2}\sigma_*^2\right) \quad (3)$$

The export efficiency can be calculated for each importing country range between 0 and 1. A score equal to 1 shows that the actual and potential exports coincides while score near to 0 reveals that the actual exports is below the potential exports. This means there are possibilities for the further exports.

The model specification of export determinants between Iran and its trading partners is specified as equation (4):

$$\begin{aligned} LnEXP_{ijt} = {} & \beta_0 + \beta_1 PCGDP_{jt} \\ & + \beta_2 POP_{jt} \\ & + \beta_3 DIS_{ij} + \beta_4 ED_{ijt} \\ & + \beta_5 LandBorder_{ij} \\ & + \beta_6 SeaBorder_{ij} \\ & + \beta_7 INT - Sanc_t \\ & + \beta_8 USA - Sanc_t \\ & + \beta_9 COVID19_t \\ & + \upsilon_{ijt} - u_{ijt} \end{aligned} \quad (4)$$

where EXP_{ijt} denotes the exports of Iran's cropland products to trading partners. $PCGDP_{jt}$ and POP_{jt} represent the GDP per capita and population of importing countries, respectively, and DIS_{ij} shows the geographical distance between Iran and importing countries as a proxy of transaction costs between countries. ED_{ijt} denotes the economic distance. Considering that Iran's trade relations with many neighboring countries are only through the sea, in this study, the common border variable between Iran and its trading partner is divided into two common land border ($LandBorder_{ij}$) and common sea border ($SeaBorder_{ij}$) variables. These variables are defined as dummy variables (i.e. 1 if Iran and importing countries have common border and 0 otherwise).The variables of $INT\text{-}SANC_t$ and $USA\text{-}SANC_t$ denote international sanction (2010-2015) and US sanction (2018-2021). These variables are defined as dummy variables (i.e. 1 for years of sanctions and otherwise).COVID19 variable shows the pandemic of COVID19 and defined as a

dummy variable (i.e. 1 for the years 2020 and 2021 and 0 otherwise). Table 1 provide expected sign and source of variables.

In order to achieve the aims of this study, the export data of selected cropland products (HS07) of Iran to 21 main importing countries, which account for more than 99% of Iran's exports, have been analyzed. The stochastic frontier gravity model is estimated from the procedure proposed by Belotti *et al.* (2013) using Stata 17 software.

Results and Discussion

The results of unit root test and collinearity test are presented in Table 2. Our findings indicated that all variables are stationary. Additionally, the results showed that there is no multicollinearity in our model.

Table 1- Data source and expected sign of each variable

Variable	Expected sign	Source
Iran's Exports		International Trade Center (ITC)
Trading partners' income	+	World Bank
Trading partners' population	+	World Bank
Geographical distance	−	CEPII
Economic difference	− / +	Author calculation based on World Bank data
Common land border	+	-
Common sea border	+	-
International Sanction (2010-2015)	− / +	Samore (2015)
US sanction (2018-2021)	− / +	-
Covid-19 pandemic (2020-2021)	− / +	-

Table 2- The results of unit root test (Levin, Lin and Chu -LLC) and multi-collinearity (VIF)

Variable	VIF	LLC	
		Coefficient	p-Value
Iran's Exports	−	-4.587	0.000
Trading partners' income	2.80	-8.442	0.000
Trading partners' population	2.10	-7.741	0.000
Geographical distance	2.73	-	-
Economic difference	2.66	-5.590	0.000
Common land border	2.05	-	-
Common sea border	2.20	-	-
International Sanction (2010-2015)	1.18	-	-
US sanction (2018-2021)	1.98	-	-
Covid-19 pandemic (2020-2021)	1.81	-	-
Mean VIF	2.17	-	-

Source: Research findings

Table 3 provides the results of stochastic frontier gravity model. Lambda coefficient is statistically significant at 1 percent level, showing that there is inefficiency and the stochastic frontier gravity model is suitable method.

The results indicated that GDP per capita of importing countries has positive and statistically significant effect at 5 percent level on Iran's cropland products exports. Increase in GDP per capita leads to increase in food demand and so more import. This result is consistent with Atif *et al.* (2017) for agricultural exports in Pakistan, Mohammadi *et al.* (2020) for pistachio exports in Iran and Mohammadi *et al.* (2022) for Iranian exports of saffron, revealing that the economic size of importing countries positively affect the exports. The population of importing countries has positive and statistically significant effect at 1 percent level on Iranian exports of cropland products. Importing countries with higher population have more imports. The distance variable has the expected negative and statistically

significant effect at 1 percent level on the exports of cropland products. This means export of cropland products is more in near importing countries. The main reasons are the high perishability of cropland products and transaction costs. The results show that economic distance between Iran and its trading partners has positive but insignificant effect on exports of cropland products. This result is contrary to the results of Mohammadi *et al.* (2020) for Iranian pistachio exports, indicating that economic distance has a significantly positive effect on pistachio exports to the trading partners. Possible reason is that pistachio is one of product with high price which leads high-income countries import more compared to other countries. The results indicated that common land border and common sea border have positive and statistically significant effect at 1 percent level on cropland products exports. Similar social and cultural factors, lifestyle and food preferences between neighboring countries leads to more food trade between them. This finding is consistent with the results of Atif *et al.* (2017) for agricultural products in Pakistan and Mohammadi *et al.* (2020) for pistachio exports in Iran. Our results show that international economic sanctions (2010-2015) and USA economic sanctions (2018-2021) have positive and significant effect on the exports of cropland products. The main reason is that important trading partners are neighboring countries such as Iraq with similar conditions. So, Iran increases the agricultural exports to trading partners with similar cultural, social and political conditions. This finding is contrary to the results of Mohammadi *et al.* (2020), showing that international economic sanctions has negative and significant effect on pistachios exports. Because EU countries as the most important trade partner of USA were main importers of Iran's pistachios and international sanctions reduced Iran's pistachio exports to these countries. Our findings reveal that COVID19 pandemic has not significant effect on exports of cropland products from Iran to its trading countries.

Table 3- The results of stochastic frontier gravity model

Variable	Coefficient	Std. dev.	T statistics	p-Value
Trading partners' income	0.358	0.156	2.30	0.022
Trading partners' population	1.032	0.136	7.56	0.000
Geographical distance	-2.190	0.435	-5.03	0.000
Economic difference	0.153	0.204	0.75	0.452
Common land border	2.606	0.510	5.11	0.000
Common sea border	2.262	0.567	3.98	0.000
International Sanction (2010-2015)	0.263	0.140	1.88	0.060
US sanction (2018-2021)	0.863	0.261	3.30	0.001
Covid-19 pandemic (2020-2021)	0.505	0.319	1.59	0.113
Constant	2.463	2.686	0.92	0.359
Lambda coefficient	7.485	1.502	4.68	0.000
Wald statistics	541.84 (0.000)			

Source: Research findings

The results of Iran's export efficiency and export potential in the destination markets are shown in Table 4. Efficiency results are reported in the period 2001-2021 and three sub-periods 2001-2007, 2008-2014 and 2015-2021. In the period of 2015-2021, Iran does not have 100 percent export efficiency in any country, and the highest level of efficiency has been observed in Afghanistan. Iran has used 65.1 percent of the Afghanistan and 35 percent of its capacity has not been used. Therefore, it can be seen that the efficiency of Iran's exports in the three countries of the United Arab Emirates, Canada and Iraq is more than 50 percent. While the lowest level of efficiency has been observed in India with 1 percent. In other words, Iran faces a high capacity (99 percent) in the Indian market. Also, the export efficiency in Türkiye (2 percent), Bahrain (2.5 percent), Kuwait (8.3 percent), Armenia (9.4 percent) and Azerbaijan

(9.4 percent) is less than 10 percent. In other words, a high export potential is observed in these countries. The results show that in the period of 2015-2021, the most unused potential is allocated to Iraq with more than 533 million dollars. Also, countries of Azerbaijan (295.3 million dollars), Pakistan (288.0 million dollars), Türkiye (238.8 million dollars), Russia (170.8 million dollars), Turkmenistan (131.0 million dollars) and Kuwait (118.8 million dollars) have an export potential of more than 100 million dollars, while the export potential of Canada, Kyrgyzstan, Georgia, Ukraine, Uzbekistan and Germany is less than 10 million dollars.

Table 4- The efficiency (EFF) and potential (PO) of Iran's export in importing countries (HS07)

Country	2021		2001-2021		2001-2007		2008-2014		2015-2021	
	EFF	PO	EFF	PO	EFF	PO	EFF	PO	EFF	PO
Afghanistan	54.90	62.0	47.50	19.5	19.10	10.0	58.30	16.3	65.10	32.2
Armenia	15.60	52.8	8.80	21.1	3.90	11.1	13.00	19.0	9.40	33.2
Azerbaijan	4.30	566.4	17.30	165.1	14.90	66.8	27.70	133.2	9.40	295.3
Bahrain	0.90	37.8	7.30	10.7	14.00	3.5	5.50	8.1	2.50	20.4
Canada	19.20	1.0	46.70	0.2	47.50	0.1	39.60	0.2	52.90	0.4
Georgia	28.70	3.6	35.80	1.2	14.30	0.8	48.40	1.0	44.80	1.9
Germany	1.90	18.8	10.20	6.1	8.70	3.6	10.00	5.0	11.80	9.9
India	0.30	173.1	19.00	54.6	66.60	11.9	0.40	45.9	1.00	92.6
Iraq	23.80	1075.1	47.10	278.2	24.00	116.1	65.00	185.3	52.20	533.3
Kazakhstan	22.30	41.1	21.20	12.7	13.80	4.1	31.80	9.9	17.80	24.3
Kuwait	2.50	213.6	7.00	69.8	9.00	27.6	3.70	62.9	8.30	118.8
Kyrgyzstan	70.30	0.5	25.80	0.2	33.10	0.1	8.30	0.2	28.50	0.4
Oman	37.50	31.6	18.10	10.5	6.90	4.0	6.10	9.8	39.70	16.7
Pakistan	10.20	536.1	12.80	163.2	21.20	63.0	6.60	138.5	10.50	288.0
Qatar	39.00	61.9	24.00	19.7	29.10	4.7	3.10	21.5	39.70	33.0
Russia	20.20	342.0	31.80	98.0	6.60	51.2	54.20	72.1	34.60	170.8
Türkiye	0.40	422.2	2.60	139.8	2.30	65.0	3.40	115.4	2.00	238.8
Turkmenistan	5.50	263.8	29.30	64.4	5.10	25.5	50.30	36.7	32.40	131.0
United Arab Emirates	57.90	114.2	65.10	35.2	61.70	12.1	70.10	29.1	63.50	64.3
Ukraine	51.90	3.7	26.30	2.1	36.80	1.2	10.60	2.2	36.10	2.5
Uzbekistan	73.20	5.1	12.80	2.5	6.40	1.1	3.10	2.9	28.40	3.8

Source: Research findings

The results of the efficiency-capacity matrix based on the time period of 2015-2021 are presented in Table 5. According to the results, among all importing countries, only Iraq has an export efficiency above 50% and export potential of more than 100 million dollars. This shows that the trading link between Iran and Iraq in the last two decades due to political, cultural and religious similarities has created suitable conditions for Iran to export agricultural products. It can also be seen that the markets of Russia, Turkmenistan and Pakistan have a high export potential with medium efficiency. So, these countries are in the main export priorities after Iraq. On the other hand, trading partners such as Canada, Ukraine, Uzbekistan, Kyrgyzstan, Germany and Georgia, have low export potential and are in the last priority. It is worth noting that the countries of Canada and Germany have no advantage in terms of geographical distance and transportation costs compared to other trading partners.

Conclusions and Policy implications

The importance of export and measuring the performance of countries in global markets has led studies to investigate the export efficiency in order to determine the degree of success of marketing programs and trading policies in destination markets. In this study, it has been tried to investigate the export of selected cropland products that have received less attention from researchers. Therefore, this study has three main objectives. First, to determine the factors affecting the Iran's cropland products exports to the main trading partners. Second, to determine the export

efficiency of Iran in destination markets. Third, to provide an efficiency/capacity matrix to present appropriate marketing packages. For these objectives, the stochastic frontier gravity model is estimated for 21 Iran's trading partners over the period of 2001-2021.

Table 5- Efficiency/Potential matrix for Iran's trading partners

		Efficiency		
		High $EFF > 50\%$	**Medium** $10\% < EFF < 50\%$	**Low** $10\% > EFF$
Future Potential	High $PO > 100\ million\$$	Iraq	Russia, Turkmenistan, Pakistan	Azerbaijan, Türkiye, Kuwait
	Medium $10\ million\$ < EFF < 100\ million\$$	UAE, Afghanistan	Kazakhstan, Oman, Qatar	Armenia, Bahrain, India
	Low $10\ Million\$ > EFF$	Canada	Ukraine, Uzbekistan, Kyrgyzstan, Germany, Georgia	–

Source: Research findings

Our findings showed that the economic and physical size of the importing countries have a positive and significant effect on Iran's exports, while the geographical distance has a negative effect. In addition, the common border has a positive and significant effect on Iran's exports. International sanctions and USA sanctions do not have a restrictive effect. In other words, sanctions has positive effect on Iran's cropland products exports. According to the results, on the one hand, Iran has export efficiency higher than 50% only in four countries, namely, Afghanistan, United Arab Emirates, Canada and Iraq. On the other hand, it can be seen that the export potential for the countries of Iraq, Azerbaijan, Pakistan, Türkiye, Russia, Turkmenistan and Kuwait was more than 100 million dollars. This means there is a lot of potential for Iran to develop the export of cropland products. Based on the results, the following suggestions can be presented. Considering the low export efficiency and high export potential, it is recommended to pay attention to the characteristics of destination markets such as health standards, customer taste preferences, cultural and social status in order to adopt appropriate marketing plans and trade policies. It is also suggested to pay special attention to competitive pricing and packaging in destination markets where there are main trading competitors such as Türkiye and Russia. Based on the results, the common border has a positive effect on Iran's exports, and considering the cultural and food similarities between Iran and its trading partners with common border, it is recommended to special attention to the market of these countries. Because cultural, social and political similarities between Iran and this group of trading partners make it easier to obtain information and generally reduce transaction costs. Considering the significant effect of GDP per capita and population, it is recommended to pay attention to the markets with large economic and physical size, which have faced market growth in recent years. For example, Iran has high export potential and high export efficiency in Iraq. In future studies, it is suggested to measure the export efficiency of Iran and its competitors in destination markets. This helps to choose the suitable destination markets with less competition in order to adopt the suitable trade policies. Especially, Türkiye and Russia have an active presence in the countries of the Middle East region like Iraq and United Arab Emirates and in Central Asian countries like Kazakhstan and Kyrgyzstan, respectively. Therefore, determining the level of competitiveness of competitors can be of great help in shaping marketing plans.

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Journal of Agricultural Economics & Development

https://jead.um.ac.ir

مقاله پژوهشی

جلد ۳۷ شماره ۲، تابستان ۱۴۰۲، ص. ۲۳۰-۲۱۷

بررسی کارایی و ظرفیت صادراتی محصولات زراعی ایران: کاربرد الگوی جاذبه مرزی تصادفی

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تاریخ دریافت: ۱۴۰۲/۰۴/۲۵

تاریخ بازنگری۱۴۰۲/۰۵/۲۹

تاریخ پذیرش: ۱۴۰۲/۰۵/۲۹

چکیده

صادرات کشاورزی ایران در سال‌های اخیر رشد قابل توجهی داشته است. در این میان محصولات زراعی (کد ۰۷) به دومین گروه مهم صادرات بخش کشاورزی ایران در سال‌های اخیر تبدیل شده است. با این وجود مطالعات اندکی به بررسی ظرفیت‌های صادراتی محصولات زراعی پرداخته‌اند. از این رو هدف این مطالعه بررسی مولفه‌های اثرگذار بر صادرات محصولات زراعی و سنجش کارایی صادرات ایران است. به منظور دستیابی به هدف، الگوی جاذبه مرزی تصادفی براساس داده‌های تابلویی متوازن برای ۲۱ کشور در دوره زمانی ۲۰۲۱-۲۰۰۱ برآورد شد. نتایج بیانگر این است که اندازه اقتصادی و فیزیکی بازار هدف اثری مثبت و معنی‌دار بر صادرات محصولات زراعی ایران داشته‌اند. همچنین مرز مشترک میان ایران و شرکای تجاری و تحریم‌های اقتصادی دارای اثری مثبت و معنی‌دار بر صادرات محصولات زراعی بوده است، در حالی‌که فاصله جغرافیایی میان ایران و کشورهای واردکننده اثری منفی بر صادرات داشته است. نتایج کارایی نشان داد که در دوره زمانی ۲۰۱۵-۲۰۲۱ ایران در هیچ بازار هدفی دارای کارایی ۱۰۰ درصدی نبوده است و در چهار کشور افغانستان، امارات متحده عربی، کانادا و عراق با کارایی بیش از ۵۰ درصد روبرو بوده است. براساس نتایج، ایران بیشترین پتانسیل صادرات محصولات زراعی را در عراق دارد. در نتیجه، با توجه به اثر مثبت و معنی‌دار مرز مشترک و ظرفیت‌های بالای شرکای تجاری هم‌مرز با ایران، پیشنهاد می‌شود که کشورهای تجاری دارای مرز مشترک مانند عراق در اولویت صادرات محصولات زراعی قرار گیرند.

واژه‌های کلیدی: پتانسیل تجاری، صادرات کشاورزی، کارایی تجاری

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DOI: 10.22067/jead.2023.83459.1202

Contents

Agricultural Economics & Development

(AGRICULTURAL SCIENCES AND TECHNOLOGY)

Vol. 37 No.2 2023

Published by: Ferdowsi University of Mashhad (College of Agriculture) Iran.

Editor in charge: Valizadeh, R. (Ruminant Nutrition)

General Chief Editor: Shahnoushi, N(Economics & Agricultural)

Publisher: Ferdowsi University of Mashhad (College of Agriculture).

Address: College of Agriculture, Ferdowsi University of Mashhad, Iran.

P.O.BOX: 91775- 1163

Fax: +98 -0511- 8787430

E-Mail: Jead2@um.ac.ir

Web Site: https://jead.um.ac.ir/

Ferdowsi University of Mashhad

Vol.37 No.2

2023

Journal of Agricultural Economics & Development

(Agricultural Sciences and Technology)

ISSN:2008-4722

Contents