



انجمن علمی اقتصاد توسعه منطقه ای

# مطالعات اقتصادی کاربردی ایران



دانشگاه بوعلی سینا

۵۵

شاپای چاپی: ۲۵۳۰-۲۳۲۲؛ شاپای الکترونیکی: ۴۷۲۸-۲۳۲۲

|| فصلنامه علمی مطالعات اقتصادی کاربردی ایران ||

|| سال ۱۴ || شماره ۵۵ || ۱۴۰۴ ||

- ۹-۴۱

بررسی تأثیر بانکداری سایه بر انتقال سیاست پولی در ایران با استفاده از رویکرد DSGE  
مهران زارعی، مرضیه اسفندیاری، سید حسین میرجلیلی

◀
- ۴۳-۶۵

مالی سازی و رفاه در ایران: پارادوکس کیفیت نهادی  
رضا معبودی، رامین خوجیانی، یونس نادمی

◀
- ۶۷-۹۱

بررسی تأثیر عدم قطعیت در عوامل مؤثر بر رد پای بوم شناختی در کشورهای منتخب آسیایی و اروپایی  
مسعود چشم اغیل، جواد شهرکی، رضا اشرف گنجویی

◀
- ۹۳-۱۱۹

ارزیابی ظرفیت اقتصادی صنعت فوتبال ایران: تحلیل شکاف عملکرد  
حمید کردبچه، لیلوفر ملکی

◀
- ۱۲۱-۱۵۱

پیش بینی بازده سهام با استفاده از روش های غیرخطی پویا: مدل سازی پارامتریک و ناپارامتریک  
سید احسان حسینی دوست، محمد حسن قطرس

◀
- ۱۵۳-۱۸۱

تأثیر تعاملی حقوق مالکیت و تحقیق و توسعه بر بهره وری کل عوامل تولید  
ابوالفضل شاه آبادی، مائده ترکمانی

◀

## راهنمای نگارش و ارسال مقاله

### ۱- محتوای شکلی مقاله

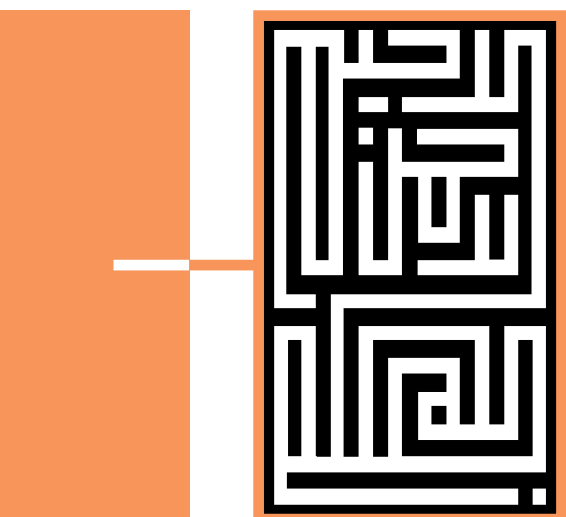
- مقاله‌های ارسالی نباید بیش از ۲۰ صفحه A۴ باشد.
- مقاله تایپ شده با قلم B Mitra ۱۳ برنامه Word ۲۰۱۰ و مطابق با معیارهای مندرج در این راهنما ارسال شود.

### ۲- ساختار علمی مقاله

- ساختار مقاله به صورت زیر تنظیم شود:
- مقدمه: شامل تعریف موضوع طرح مسأله و بیان اهداف.
- بررسی پیشینه: موضوع و چارچوب نظری و طرح پرسش‌ها/ یا فرضیات تحقیق.
- روش‌شناسی تحقیق: روش تحقیق متغیرهای مورد بررسی و فنون گردآوری و تحلیل داده‌ها.
- ارائه یافته‌ها، تجزیه و تحلیل و تفسیر آن‌ها.
- جمع‌بندی و نتیجه‌گیری.
- یادداشت‌ها و پیوست‌ها (در صورت لزوم).
- فهرست منابع فارسی و انگلیسی به روش APA.
- خلاصه‌ای از سوابق و علایق آموزشی و پژوهشی نویسنده/ نام دانشگاه یا مؤسسه وابسته/ نشانی الکترونیکی.
- چکیده انگلیسی همراه با کلیدواژه‌ها در پایان مقاله.

### ۲- شیوه ارجاع و استناد

- ارجاع در متن مقاله
- پس از مطلب اقتباس شده، مستقیم یا غیرمستقیم: (نام خانوادگی صاحب اثر، سال انتشار: شماره صفحه یا صفحات).
- در صورتی که اثر مورد استفاده به زبان فارسی ترجمه شده باشد، تاریخ انتشار اثر ترجمه شده و در غیر این صورت تاریخ انتشار متن به زبان اصلی ذکر شود.
- ارجاع در پایان مقاله (کتابنامه)
- فهرست منابع مورد استفاده در پایان مقاله به ترتیب الفبایی حرف اول نام خانوادگی نویسنده یا صاحب اثر به شرح زیر تنظیم گردد.



بسمه تعالی  
گواهی رتبه علمی



جمهوری اسلامی ایران  
وزارت علوم، تحقیقات و فناوری  
معاونت پژوهش و فناوری  
کمیسیون نشریات علمی

نشریه

مطالعات اقتصادی کاربردی ایران

با صاحب امتیازی دانشگاه بوعلی سینا بر اساس آیین نامه  
نشریات علمی مصوب ۱۳۹۸/۰۲/۰۹ در ارزیابی سال  
۱۳۹۹، موفق به کسب رتبه الف شده است.

بی تردید تلاش دست اندرکاران آن نشریه سهم بسزایی در  
گسترش مرزهای دانش و ارتقای کیفی و کمی جایگاه علمی  
کشور خواهد داشت.

محسن شریفی  
مدیر کل دفتر سیاستگذاری و برنامه ریزی  
امور پژوهشی و دبیر کمیسیون نشریات  
علمی

رتبه علمی

الف

پروسی صحت گواهی در :  
JOURNALS.MSRT.IR



مدیریت پژوهش و فناوری ایران  
سامانه یکپارچه مدیریت  
اطلاعات پژوهشی و فناوری  
MAPFA.MSRT.IR

فصلنامه علمی

## مطالعات اقتصادی کاربردی ایران

نشریه گروه اقتصاد، دانشکده علوم اقتصادی و علوم اجتماعی دانشگاه بوعلی سینا

با همکاری انجمن علمی اقتصاد توسعه منطقه‌ای

آغاز انتشار: آذرماه ۱۳۹۶

شاپای چاپی: ۲۵۳۰-۲۳۲۲

شاپای الکترونیکی: ۴۷۲X-۲۳۲۲

شماره مجوز ارشاد: ۲۲۷۸۷

نشریه دارای درجه علمی از کمیسیون بررسی اعتبار نشریات علمی وزارت علوم، تحقیقات و فناوری براساس رأی

جلسه مورخ ۱۳۹۰/۱۲/۲۴ به شماره ۲/۲۷۱۰۱۶ به فصلنامه علمی پژوهشی است.

ناشر: دانشگاه بوعلی سینا



© حق انتشار این مستند، متعلق به نویسندگان آن است. ۱۴۴۰. ناشر این مقاله، دانشگاه بوعلی سینا است.

این مقاله تحت گواهی زیر منتشر شده و هر نوع استفاده غیرتجاری از آن مشروط بر استناد صحیح به مقاله و با رعایت شرایط مندرج در آدرس زیر مجاز است.

Creative Commons Attribution-NonCommercial 4.0 International license (<https://creativecommons.org/licenses/by-nc/4.0/>).

نشانی پایگاه نشریه: <https://aes.basu.ac.ir/>

| مطالعات اقتصادی کاربردی ایران              |                                                                      |
|--------------------------------------------|----------------------------------------------------------------------|
| فصلنامه علمی مطالعات اقتصادی کاربردی ایران |                                                                      |
| شماره ۵۵، سال ۱۴                           |                                                                      |
| ۹-۴۱                                       | پرسش نامرئی در مورد بهای به اشتراک گذاری در ایران: بازنگری و پیشنهاد |
| ۴۲-۵۲                                      | بازی سانی و بازی در ایران: بازیهای تکاملی و بازیهای تکاملی           |
| ۵۳-۶۱                                      | پرسش نامرئی در مورد بهای به اشتراک گذاری در ایران: بازنگری و پیشنهاد |
| ۶۲-۷۱                                      | پرسش نامرئی در مورد بهای به اشتراک گذاری در ایران: بازنگری و پیشنهاد |
| ۷۲-۸۱                                      | پرسش نامرئی در مورد بهای به اشتراک گذاری در ایران: بازنگری و پیشنهاد |
| ۸۲-۹۱                                      | پرسش نامرئی در مورد بهای به اشتراک گذاری در ایران: بازنگری و پیشنهاد |
| ۹۲-۱۰۱                                     | پرسش نامرئی در مورد بهای به اشتراک گذاری در ایران: بازنگری و پیشنهاد |
| ۱۰۲-۱۱۱                                    | پرسش نامرئی در مورد بهای به اشتراک گذاری در ایران: بازنگری و پیشنهاد |
| ۱۱۲-۱۲۱                                    | پرسش نامرئی در مورد بهای به اشتراک گذاری در ایران: بازنگری و پیشنهاد |
| ۱۲۲-۱۳۱                                    | پرسش نامرئی در مورد بهای به اشتراک گذاری در ایران: بازنگری و پیشنهاد |
| ۱۳۲-۱۴۱                                    | پرسش نامرئی در مورد بهای به اشتراک گذاری در ایران: بازنگری و پیشنهاد |

## فصلنامه علمی مطالعات اقتصادی کاربردی ایران

سال ۱۴، شماره ۵۵، ۱۴۰۴

شاپای چاپی: ۲۵۳۰-۲۳۲۲  
شاپای الکترونیکی: ۴۷۲۲-۲۳۲۲  
صاحب امتیاز: دانشگاه بوعلی سینا  
با همکاری: انجمن علمی اقتصاد توسعه منطقه ای  
مدیر مسئول: سعید عیسی زاده  
سر دبیر: محمد حسن فطرس  
مدیر اجرایی: اسماعیل ترکمنی  
مدیر داخلی و کارشناس: خلیل الله بیگ محمدی  
ویراستار انگلیسی: آذر سرمدی جو  
طراح لوگو: حمیدرضا چتربحر

### هیأت تحریریه (به ترتیب حروف الفبا)

محسن بهمنی اسکویی (استاد گروه اقتصاد دانشگاه ویسکانسین آمریکا)  
محمد هاشم پسران (استاد گروه اقتصاد دانشگاه کمبریج انگلستان)  
محمد رضا فرزنانگان (استاد گروه اقتصاد دانشگاه فیلپس ماربورگ آلمان)  
امیر کیا (استاد گروه اقتصاد دانشگاه یوتای آمریکا)  
اسفندیار معصومی (استاد گروه اقتصاد کالج اموری، آمریکا)  
عبدالکریم ذولکفلی (استاد گروه اقتصاد، دانشکده علوم اقتصادی و اجتماعی، دانشگاه ملی مالزی)  
سید عزیز آرمن (استاد گروه اقتصاد، دانشکده علوم اقتصادی و اجتماعی، دانشگاه شهید چمران اهواز، اهواز، ایران)  
مصیب پهلوانی (دانشیار گروه اقتصاد، دانشکده اقتصادی، دانشگاه سیستان و بلوچستان، زاهدان، ایران)  
سعید راسخی (استاد گروه اقتصاد، دانشکده علوم اقتصادی و اجتماعی، دانشگاه مازندران، مازندران، ایران)  
محمد علیزاده (دانشیار گروه اقتصاد، دانشکده علوم اقتصادی و اجتماعی، دانشگاه لرستان، لرستان، ایران)  
سعید عیسی زاده (دانشیار گروه اقتصاد، دانشکده علوم اقتصادی و اجتماعی، دانشگاه بوعلی سینا، همدان، ایران)  
علی حسین صمدی (دانشیار گروه اقتصاد، دانشکده علوم اقتصادی و اجتماعی، دانشگاه شیراز، شیراز، ایران)  
محمد حسن فطرس (استاد گروه اقتصاد، دانشکده علوم اقتصادی و اجتماعی، دانشگاه بوعلی سینا، همدان، ایران)  
محمد قربانی (استاد گروه اقتصاد کشاورزی، دانشکده کشاورزی، دانشگاه فردوسی، مشهد، ایران)  
محمد رضا لطفعلی پور (استاد گروه اقتصاد، دانشکده علوم اقتصادی و اجتماعی، دانشگاه فردوسی، مشهد، ایران)  
محمد علی متفکر آزاد (استاد گروه توسعه اقتصادی، دانشکده علوم اقتصادی و اجتماعی، دانشگاه تبریز، تبریز، ایران)  
نادر مهرگان (استاد گروه اقتصاد، دانشکده علوم اقتصادی و اجتماعی، دانشگاه بوعلی سینا، همدان، ایران)  
محمود هوشمند (استاد گروه اقتصاد، دانشکده علوم اقتصادی و اجتماعی، دانشگاه فردوسی، مشهد، ایران)

پست الکترونیکی نشریه: Email: [aesi@basu.ac.ir](mailto:aesi@basu.ac.ir)

وبسایت: <https://aes.basu.ac.ir/>

آدرس نشریه: همدان، چهارباغ شهید احمدی روشن، دانشگاه بوعلی سینا، ساختمان مرکزی، معاونت پژوهشی، دفتر نشریات علمی دانشگاه.  
تلفن: ۰۸۱-۳۱۴۰۱۴۵۵

- ۹-۴۱ بررسی تأثیر بانکداری سایه بر انتقال سیاست پولی در ایران با استفاده از رویکرد DSGE  
مهران زارعی، مرضیه اسفندیاری، سید حسین میرجلیلی
- ۴۳-۶۵ مالی سازی و رفاه در ایران: پارادوکس کیفیت نهادی  
رضا معبودی، رامین خوچانی، یونس نادمی
- ۶۷-۹۱ بررسی تأثیر عدم قطعیت در عوامل مؤثر بر رد پای بوم‌شناختی در کشورهای منتخب  
آسیایی و اروپایی  
مسعود چشم‌اغیل، جواد شهرکی، رضا اشرف گنجویی
- ۹۳-۱۱۹ ارزیابی ظرفیت اقتصادی صنعت فوتبال ایران: تحلیل شکاف عملکرد  
حمید کردبچه، نیلوفر ملکی
- ۱۲۱-۱۵۱ پیش‌بینی بازده سهام با استفاده از روش‌های غیرخطی پویا: مدل سازی پارامتریک و  
ناپارامتریک  
سید احسان حسینی دوست، محمدحسن فطرس
- ۱۵۳-۱۸۱ تأثیر تعاملی حقوق مالکیت و تحقیق و توسعه بر بهره‌وری کل عوامل تولید  
ابوالفضل شاه‌آبادی، مائده ترکمانی

ملیحه آشنا  
رقیه پوران  
هانیه ثمری  
زینب دره نظری  
نظر دهمرده  
ابوالفضل شاه آبادی  
محمد حسن فطرس  
ابوالقاسم گلخندان  
نادر مهرگان  
یونس نادمی

**Applied Economics Studies, Iran (AESI)**P. ISSN:2322-2530 & E. ISSN: 2322-472X - Journal Homepage: <https://aes.basu.ac.ir/>

Scientific Journal of Department of Economics, Faculty of Economic and Social Sciences, Bu-Ali Sina University, Hamadan, Iran. Owner &amp; Publisher: Bu-Ali Sina University.

© Copyright © 2025 The Authors. Published by Bu-Ali Sina University.

This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International license (<https://creativecommons.org/licenses/by-nc/4.0/>). Non-commercial uses of the work are permitted, provided the original work is properly cited.Bu-Ali Sin  
University

## The Impact of Shadow Banking on the Transmission of Monetary Policy in Iran: A DSGE Model Approach

Mehran Zarei<sup>1</sup> , Marziyeh Esfandiari<sup>2</sup> , Seyed Hossein Mirjalili<sup>3</sup> 

Type of Article: Research

 <https://doi.org/10.22084/aes.2025.30883.3788>

Received: 2025.04.29; Revised: 2025.06.30; Accepted: 2025.17.11

Pp: 9-41

### Abstract

Monetary policy is one of the most important tools for policymakers to influence macroeconomic variables including production. However, implementing this policy sometimes yields unintended consequences. Understanding monetary policy transmission mechanisms is therefore critical for effective implementation. Research following the 2008-2009 financial crisis indicates that the shadow banking activity can disrupt the monetary policy transmission and weaken its effectiveness. An analysis of Iran's financial system reveals increasing shadow banking activity. This paper therefore examines how shadow banking affects monetary policy transmission in Iran using a DSGE model that innovatively incorporates the shadow banking sector. We compare two scenarios: a financial system without shadow banking and one including shadow banking. The effects of two contractionary monetary policies—interest rate increase and reductions in money supply growth—on GDP, investment, and inflation were analyzed under each scenario. The findings indicate that shadow banking diminishes monetary policy's impact on all three variables by weakening the credit channel of monetary policy transmission. In the scenario without shadow banking, all three variables will decline in response to the monetary shock of decreasing money supply growth. However, in the scenario with shadow banking, investment levels are not declining but rising. The impact of monetary policy on output and inflation is diminished in the presence of shadow banking. In the case of interest rate shocks, the results also indicate a negative impact of shadow banking on the effectiveness of monetary policy.

**Keywords:** Shadow Banking, Monetary Policy, Output, DSGE Model, Iran's Economy.

**JEL Classification:** E42, E44, E51, E52, G20.

1. Ph.D. Student in Economics, Faculty of Economics and Administrative Sciences, University of Sistan and Baluchestan, Zahedan, Iran.

2. Associate Professor, Department of Economics, Faculty of Economics and Administrative Sciences, University of Sistan and Baluchestan, Zahedan, Iran (Corresponding Author). **Email:** [m.esfandiari@eco.usb.ac.ir](mailto:m.esfandiari@eco.usb.ac.ir)

3. Professor, Department of Economics, Faculty of Economics, Institute for Humanities and Cultural Studies, Tehran, Iran.

**Citations:** Zarei, M., Esfandiari, M. & Mirjalili, S. H., (2025). "The Impact of Shadow Banking on the Transmission of Monetary Policy in Iran: A DSGE Model Approach". *Journal of Applied Economics Studies in Iran*, 14(55): 9-41. <https://doi.org/10.22084/aes.2025.30883.3788>

**Homepage of this Article:** [https://aes.basu.ac.ir/article\\_6147.html?lang=en](https://aes.basu.ac.ir/article_6147.html?lang=en)

## 1. Introduction

Monetary policy is a crucial macroeconomic tool for influencing economic variables. Consequently, governments and monetary authorities have consistently employed this policy to achieve economic objectives, particularly since the 1960s. Although monetary policy is a powerful instrument, it sometimes yields unexpected or unwanted outcomes (Mishkin, 1995). Thus, the extent and direction of monetary policy effectiveness remain key concerns for monetary authorities, giving rise to the concept of "monetary policy transmission" in economic literature.

Monetary policy transmission refers to the process through which a monetary policy (changes in nominal interest rates or money supply) affects real economic variables such as employment and output. The mechanism of monetary policy transmission explains how monetary policy impact on real variables. Understanding these mechanisms is essential for effective policy implementation. Transmission mechanisms are broadly categorized into four channels: interest rate, exchange rate, other asset price effects, and credit channels (Arabian *et al.*, 2020). Some scholars also identify expectations as a fifth channel (e.g., Bajelan *et al.*, 2018).

Mishkin (2019) argues that the emergence of shadow banking can be traced back to the economic changes of the 1960s. Since the 1960s, individuals and financial institutions in financial markets have faced drastic changes in the economic environment. These changes included: 1- Inflation and interest rate fluctuations increased sharply and became more difficult to predict, a situation that changed the demand conditions in financial markets. 2- Vast advances in computer technologies transformed the supply conditions. 3- Financial regulations became stricter. Financial institutions found that in these conditions, many of the old methods in this market were no longer profitable. In response to these conditions, financial deregulation began in the 1970s. In this context, financial innovations rapidly expanded and new financial instruments were introduced. These changes led to the process from which shadow banking grew; the process of 'securitization'.

Following financial deregulation in the United States during the 1970s, numerous financial intermediaries have emerged which intermediated between savers and borrowers through financial innovations. Although functioning as financial intermediaries, these entities were not categorized as banks and consequently not subject to rigorous central bank supervision. Many scholars argue that these non-bank intermediaries, —termed "shadow banks"—, played a major role in the 2007-2009 financial crisis (Yang *et al.*, 2019).

The expansion of non-bank financial intermediaries may undermine monetary policy effectiveness by weakening the credit channel of monetary policy transmission. Given that

these intermediaries connect firms, workers, and government policies, some researchers have examined shadow banking from a political economy perspective (e.g., [Fisher & Bernardo, 2014](#); [Ban & Gabor, 2016](#)).

Over the past two decades, shadow banking activity in Iran, while modest compared to many countries, has increased significantly. Therefore, it is necessary to examine the impact of shadow banking on the economy, especially its impact on monetary policy transmission and macroeconomic variables. While a review of studies related to the Iranian economy shows that this issue has been neglected by researchers and policymakers. Therefore, the main question of the present article is whether shadow banking in Iran weakens the transmission of monetary policy in Iran? To answer this question, this paper addresses this gap using a DSGE model to analyze shadow banking's impact on monetary policy transmission in Iran.

The remainder of this paper is organized as follows. section 2 reviews the theoretical background; section 3 surveys relevant literature; section 4 details the model; section 5 presents empirical results; and section 6 concludes with policy recommendations.

## 2. Theoretical background

### 2-1. Monetary Policy and Its Transmission Mechanisms

Empirical studies confirm early finding of [Friedman and Schwartz \(1965\)](#) that monetary policy actions lead to changes in real output ([Bernanke and Gertler, 1995](#)). Therefore, most economists agree that monetary policy can influence real economic variables, at least in the short run. Over recent decades, there has been a growing consensus among economists and politicians that stabilization of output and inflation should be left to monetary policy. Since the 1960s, fiscal policy has lost some credibility and luster due to concerns about large budget deficits, because of doubts about the political system's ability to make sound and timely decisions about spending and taxes. Consequently, monetary policy has assumed greater prominence in macroeconomic policymaking ([Mishkin, 1995](#)). Nevertheless, monetary policy can occasionally yield unanticipated and unwanted consequences that adversely affect public welfare. Therefore, understanding the transmission mechanisms of monetary policy is crucial for the implementation of such policies.

[Mishkin \(1995; 1996\)](#) categorizes monetary policy transmission into four channels: the interest rate; the exchange rate; the other asset price, and credit. Each of these channels is explained below.

### a) Interest Rate Channel

Interest rate transmission can be considered as the main mechanism of monetary policy transmission. The traditional Keynesian perspective of how monetary contraction is transmitted to the real variables of the economy can be shown schematically below:

The reduction of the money supply (a contractionary monetary policy) results in the rise of real interest rate which results in an increase in the cost of financing and; this, in turn, discourages investment. Subsequently, aggregate demand and aggregate output will both decline. Prior research suggested that the interest rate channel operated solely through the investment spending decisions of businesses. However, subsequent studies have demonstrated that interest rates also impact on the expenditure decisions of households, especially housing and durable goods. For example, an increase in real interest rates leads households to try to postpone consumption. Current consumption is reduced compared to future consumption. With sticky prices, a reduction in current aggregate demand reduces output (Walsh, 2017).

According to John Taylor, the interest rate is a crucial element in the transmission of monetary policy. In the Taylor model, contractionary monetary policy raises the short-term interest rates, and considering price rigidity and rational expectations the long-term interest rate also increases (Mishkin, 1996; Bajelan *et al.*, 2018). It diminishes the formation of fixed capital, reduces spending on durable goods, and raises the cost of housing for households; and consequently, the total output declines.

### b) Exchange Rate Channel

With the advent of flexible exchange rates in the 1970s, monetary policy transmission via the effects of exchange rates on net exports attracted attention. Foreign currency deposits become less attractive than domestic deposits denominated in the national currency when domestic interest rates increase. Consequently, the domestic currency appreciates relative to foreign currencies. An appreciation of the domestic currency (foreign currency depreciation) leads to a higher price for domestic goods relative to foreign goods, thereby causing a contraction in exports and output (Mishkin, 1995 & 1996). The aforementioned effects are illustrated in the following diagram.

### c) Other Asset Price Effects

In his critique of the Keynesian approach to the monetary policy transmission mechanism, Allan Meltzer highlights the narrow focus of this analysis, which is limited to the relative price of an asset, specifically the interest rate. When analyzing monetary policy

transmission mechanisms, monetarists contend that it is important to examine how this policy type affects the relative prices of assets and real wealth. The asset price channel, in addition to bond prices, also focuses on other asset prices, including stock prices and real estate prices (Li *et al.*, 2021). In this regard, two monetary policy transmission channels are highlighted: The Tobin's  $q$  theory on investment and the impact of wealth on consumption.

According to Tobin's theory, the ' $q$ ' is the ratio of firms' market value to the replacement cost of capital. When  $q$  is high, then firms' market value relative to the cost of capital replacement will be high. Additionally, the price of fixed capital and equipment will be lower than the market value of business firms. Firms can therefore issue shares at a relatively high price (compared to fixed capital) and generate substantial profits. As a result, their investment expenditures rise, as issuing a limited number of shares enables them to acquire a substantial quantity of capital goods. However, when the value of  $q$  is low, firms will be reluctant to acquire capital goods for the same reason.

According to monetarists, when the money supply decreases, the public finds they have less money than they want and attempts to control it by reducing their spending. The stock market is where people can reduce their expenditures, as this decreases the demand for securities and, by extension, their prices. Given that a decrease in stock price ( $P_e$ ) leads to lower ' $q$ ' and thereby investment costs ( $I$ ), the monetary policy transmission mechanism can be conceptualized as follows from a monetarist standpoint:

A similar argument is also advanced in support of wealth effects, according to Modigliani's life cycle theory of consumption. A decline in stock prices leads to a corresponding reduction in individuals' financial wealth ( $W$ ), which subsequently reduces their consumption ( $C$ ). Aggregate demand and aggregate output will decline as a result of decreased consumption.

#### **d) Credit Channel**

Contrary to the monetary view that emphasizing money's exclusive role in transmission, the credit perspective focuses specifically on credit (De Bondt, 1999). Bernanke & Gertler (1995) argue that the credit channel augments traditional monetary transmission mechanisms (e.g., the interest rate channel) and therefore cannot be considered as an independent channel. However, this primarily applies to developed economies. Empirical evidence suggests that in emerging markets with imperfect financial systems, monetary policy transmission occurs predominantly through the credit channel—particularly the bank lending channel.

The credit channel perspective highlights how the agency problem in financial markets is formed by asymmetric information and costly contract enforcement. Two primary monetary policy transmission channels result from the agency problem in credit markets: the bank's lending channel and the balance sheet channel. The premise underlying the bank lending channel is that banks play a pivotal role within the financial system, particularly for small enterprises and households. Furthermore, it is assumed that bank loans and alternative funding sources are not complete substitutes, given that a considerable number of borrowers, particularly households and small and medium-sized businesses, lack the financial means to finance through bond issuance.

A contractionary monetary policy diminishes bank reserves and deposits (D), thereby diminishing banks' ability to lend (L). It diminishes both firms' and individuals' expenditures on investments and consumption. The figure below illustrates how this channel operates:

Following financial innovations since the 1970s, and the reducing role of banks in financial system, the balance sheet channel of monetary policy transmission gained greater prominence. This channel functions through commercial enterprises' net worth. Lower net worth means that lenders have less collateral for their lending, and thereby, losses attributable to financial intermediaries' adverse selection will be greater. As a result, financing for investment expenses of enterprises is diminished. A decline in business firms' net worth also exacerbates the problem of moral hazard, as proprietors will have less equity in their own company and will be more inclined to undertake risky investment endeavors. High-risk investment endeavors increase the likelihood of loan default; consequently, this results in reduced lending activity and decreased investment expenses.

Monetary policy can impact enterprises' balance sheets in numerous ways. The implementation of a contractionary monetary policy results in a decline in stock prices, which subsequently impacts the net assets of enterprises. The aforementioned discussions suggest that an increase in moral hazard and adverse selection will lead to a reduction in bank lending. Consequently, this will result in a decrease in companies' investment expenditures, ultimately causing a decline in aggregate output.

## 2-2. Shadow Banking and Monetary Policy Transmission

By the 1970s, conventional banks played a substantial role in the financial system. Central banks imposed stringent regulations on them while implementing monetary policy. Since then, however, the United States government has enacted extensive deregulations in the

financial sector, leading to the rapid expansion of so-called non-bank financial intermediaries. These non-bank financial institutions are known as “shadow banking”.

Paul McCulley coined the term “shadow banking system” to refer to “the whole alphabet soup of levered up non-bank investment conduits, vehicles, and structures”. Various definitions of shadow banking have been proposed, each serving a specific purpose. However, the definition put forth by the Financial Stability Board (FSB) is widely regarded as the most straightforward and conventional. According to this definition, shadow banking is “the system of credit intermediation that involves entities and activities outside the regular banking system” ([Financial Stability Board, 2011](#)). Insurance companies, pension funds, mutual investment Funds, hedge Funds, money market Funds, and investment banks are among the most significant of these entities. In addition, in some cases, especially under the strict central bank regulations, traditional banks provide off-balance sheet financing to escape central bank regulations. In the literature related to shadow banking, this type of activity by traditional banks is known as shadow banking, and it is especially intense in China. For example, [Yang et al., \(2019\)](#), [Huang \(2018\)](#), and [Chen et al., \(2018\)](#) considered off-balance sheet financing by traditional banks as a form of shadow banking in their research.

Due to the lack of strict supervision, the shadow banking system facilitates the circumvention of the regulatory frameworks ([Schairer, 2024](#)). Therefore, Shadow banking interferes with the lending role of traditional banks and may reduce the effectiveness of monetary policy ([Cheng and Wang, 2022](#)). As a result of the expansion of shadow banking, a larger part of the financial system is now not subject to tight central bank supervision; consequently, the central bank’s regulations have no bearing on their operations. Therefore, the lending channel of monetary policy transmission is weakened since the expansion of shadow banking undermines the assumption of the lending channel (that bank loans and alternative funding sources are not complete substitutes).

The amount of lending by commercial banks decreases in response to a tight credit policy enforced by the central bank. However, shadow banking, which operates outside the purview of central bank supervision, does not follow these regulations. As a result, some businesses and households denied loans from conventional financial institutions resort to shadow banking as an alternative method of borrowing. Based on this, and assuming the incomplete substitution of bank loans with other credit supply channels, the decrease in bank loans is compensated by shadow lending ([Gong et al., 2021](#)). Therefore, as the proportion of shadow banking expands and the share of conventional banks diminishes, monetary policies affect only a small part of the financing system and their effectiveness

will decrease. Conversely, when expansionary monetary policy is implemented, the money supply increases and interest rates decrease. In this situation, conventional lending channels (traditional banks) replace shadow banking (substitution effects), which slows down the growth of this type of banking or even makes its growth negative.

### 2-3. Shadow Banking in Iran

Research on shadow banking in Iran remains limited. [Arbab Afzali et al., \(2015\)](#) estimated the size of shadow banking in Iran for the first time in their research. According to their estimates, the value of shadow bank assets in Iran has increased from less than 50 trillion rials in 2009 to more than 400 trillion rials in 2013. Also, the ratio of the value of shadow banking assets to GDP in Iran has increased from 4% in 2009 to 76% in 2013, which indicates the strong growth of this type of banking activity during the years under review. [Makipour et al., \(2023\)](#) in their article estimated the size of shadow banking assets in Iran during the years 2009 to 2020. According to the estimates of this article, the value of shadow banking assets in Iran in 2020 was more than 400,000 trillion Tomans (4000,000 trillion rials).

In this study, to quantifies Iran's shadow banking activity, we examined the assets of intermediaries introduced by the Financial Stability Board as shadow banking. Three different indexes have been used to examine the trend of shadow banking activity in Iran over the past years: 1) total value of shadow banking assets, 2) the ratio of the value of shadow banking assets to the total assets of the banking system (traditional and shadow), and 3) ratio of the value of shadow banking assets to GDP. In Iran, Non-bank credit institutions, insurance companies, investment funds, pension funds, and leasing companies are examples of these intermediaries. The asset value of shadow banking in Iran from 2011 to 2022 is depicted in figure 1.

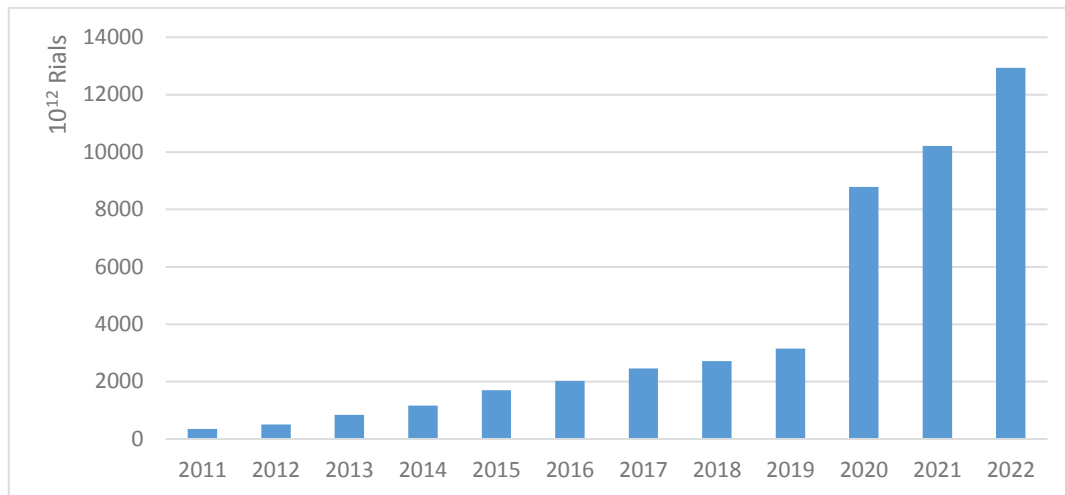


Fig. 1: Value of shadow banking assets in Iran (thousand billion Rials). Source: Kodal and Rahvard Novin

Figure 1 illustrates that the value of shadow banking has risen steadily over the period, from approximately 351 thousand billion Rials in 2011 to 12,936 thousand billion Rials in 2022, representing an annual growth rate of 38.8%. The asset value of these intermediaries witnessed its most substantial annual increase, approximately 178% in 2020.

To provide a clearer illustration of shadow banking in Iran, Figures 2 and 3 illustrate the ratio of shadow banking's value to the banking system's total value and to the GDP as a whole. It is evident from figure 2 that the ratio of shadow banking's value to that of all banks has exhibited a consistent upward trend until 2020, increasing from an estimated 10.9% to 28.5%. However, subsequent to that period, and in light of the liquidation of certain non-banking financial institutions, this ratio declined to 23.1% in 2022.

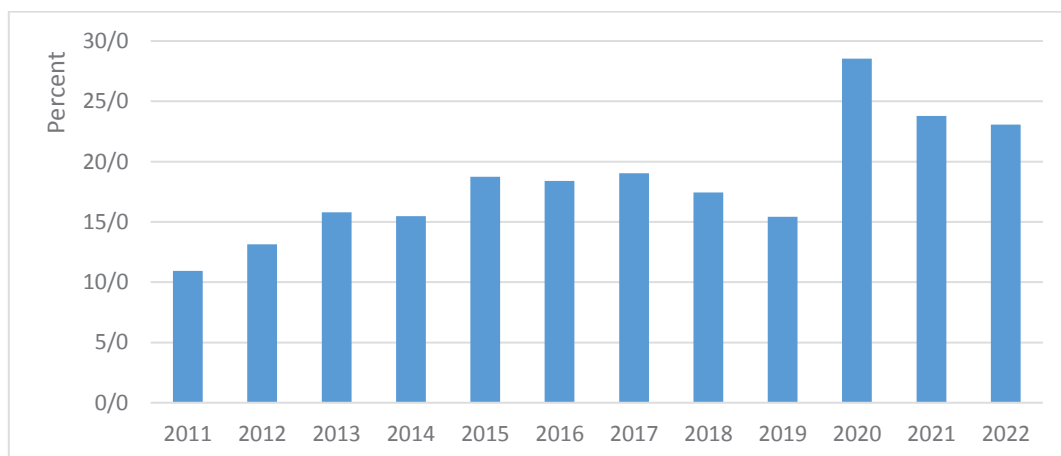


Fig. 2: The ratio of shadow banking assets to the total assets of the banking system (shadow and traditional) (percent) Source: Kodal and Rahvard Novin

The ratio of shadow banking value to GDP value is also displayed in Figures 3.

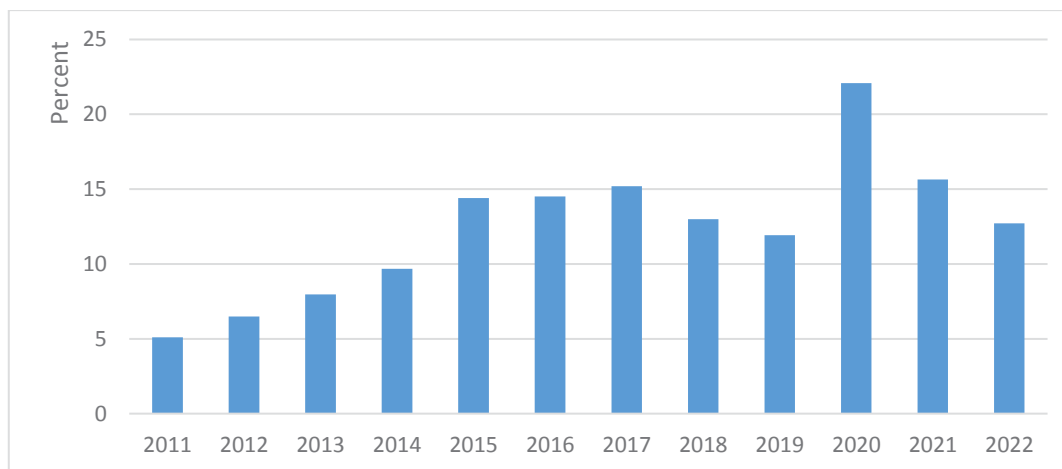


Fig. 3: Ratio of shadow banking assets to GDP value (percent). Source: Central Bank, Kodal and Rahvard Novin

### 3. Literature Review

Shadow banking concept appeared in the economic literature subsequent to the financial crisis of 2007-2009, therefore, research pertaining to it, such as its impact on the transmission of monetary policy, lacks an extensive historical background. Generally, the research pertaining to shadow banking is structured into two categories: theoretical and experimental. Some studies have examined shadow banking and its role in the economy from a theoretical view and have tried to provide a framework for its analysis. However, experimental investigations into its impact on economic variables have been conducted by others. Following is a review of some of the most important related studies.

Tobias Adrian, one of the theoretical pioneers of shadow banking, has provided a theoretical explanation for its existence in the economy. According to [Adrian & Shin \(2008\)](#), monetary policy transmission is centered on financial intermediaries, and the balance sheets of market-based financial intermediaries provide a window through which monetary policy transmission can go through capital market conditions. They argue that the 2007-2009 financial crisis is unique among previous crises in that it is the first financial crisis after securitization. Additionally, [Adrian & Shin \(2009\)](#) examined the origins and the contribution of shadow banking to the 2008 financial crisis and indicated that shadow banking emerged as a consequence of asset securitization and the banking system's integration with capital market developments. Initially perceived as a method to credit risk transfer, securitization ultimately intensified the vulnerability of the entire financial system

due to the fact that banks and other financial intermediaries could purchase each other's securities to increase their banking leverage.

[Funke et al., \(2015\)](#) examined the impact of liberalization of interest rate on monetary policy transmission and the dynamics of the shadow banking using a DSGE model including shadow banking. They indicated that a rise in lending of shadow banking results from the tight interest rate policy implemented by traditional banks. As anticipated, their findings indicate that raising the policy interest rate leads to a decrease in investment, output, and inflation. However, the effects of this policy are lessened when the interest rate is liberalized.

[Mazelis \(2015\)](#) investigates the heterogeneous effects of monetary policy shocks on financial intermediaries focusing on the differentiation between shadow banking and commercial banking. As banks' credits endogenously responds to economy-wide productivity, the bank's response to shocks corresponds to the balance sheet channel. The lending channel provides the most adequate explanation for shadow banking behavior, given their constrained financial resources. The findings of this article indicate that shadow banking operations undermines the effectiveness of monetary policy due to the inverse relationship between the trajectory of shadow banking loans and traditional bank loans in the aftermath of monetary policy shocks.

In their article, [Chen et al., \(2018\)](#) provided a theoretical examination of the relationship between shadow banking and monetary policy in China and defined shadow banking as the off-balance sheet activities of banks. The contractionary monetary policy that diminishes the lending capacity of shadow banking, as indicated by their research, motivates these banks to allocate funds towards risky non-loan assets to avoid central bank regulations.

Using the DSGE model, [Yang et al., \(2019\)](#) examined the impact of shadow banking on economic activities and the effectiveness of monetary policy in China. Their findings indicate that shadow banking can reduce the effectiveness of macro prudential policy and disturb the transmission of monetary policy. Shadow banking will enhance welfare in the face of technology shocks, bank net asset shocks, and loan quota shocks; and conversely, welfare is diminished in the face of monetary policy shocks. Their findings also indicate that regulatory regulation aimed at improving financial stability could have a negative effect on the economy. Highlighting that regulations aim to strike a balance between the costs and benefits of policy intervention, they propose coordination between monetary policy and leverage ratio regulation to stabilize the economy and decrease shadow banking.

In the context of the CC-LM model, [Zhang et al., \(2020\)](#) examined the effect of shadow banking on the prospective effectiveness of monetary policy. Their model shows that

shadow banking has the potential to influence the rate of money creation, causing it to increase during times of expansion and decrease during times of contraction. The introduction of shadow banking to the CC-LM model induces a transfer of the CC and LM curves, which ultimately culminates in an increase in equilibrium production.

Gong *et al.*, (2021) using a DSGE model, examined the effects of shadow banking on monetary policy. The results indicate that the shadow banking in China exhibits countercyclical attributes. The model's numerical analyses indicate that increases in interest rates that are positive shocks in nature stimulate the shadow banking growth and augment its credit leverage, while concurrently diminishing the credit leverage of commercial banks. These findings indicate that although shadow banking has partially addressed the problem of credit resource misallocation, it weakens the effectiveness of monetary policy through the credit channel and worsens financial instability, as indicated by these findings. They assert that to enhance the effectiveness of monetary policy, the process of liberalization of interest rate must be accelerated and supervision of the shadow banking need to be strengthened.

Agarwal *et al.*, (2022) examine the transmission of monetary policy through shadow banking in the mortgage market, with a specific focus on the role of mortgage servicing in the creation of non-deposit funds for lending. They argue that housing mortgage loan services mitigate the impact of monetary policy on shadow banking mortgage loans and serve as a natural hedge against interest rate shocks. The estimations presented in this article suggest that as the proportion of shadow banking in mortgage services rises, the transmission of monetary policy to the overall mortgage loan market is weakened.

Le *et al.*, (2022), in their study examines how regulatory arbitrage and shadow banking activities in China have impacted the effectiveness of monetary policy focusing on the influence of regulatory arbitrage. The authors argue that regulatory arbitrage is a persuasive explanation for the rapid growth of credits in the shadow banking sector. For instance, the implementation of a loan-to-deposit ratio (LDR) cap of 75% between 2009 and 2015 incentivized conventional banks to lend to SMEs via shadow banking in order to circumvent regulations and thereby contribute to the shadow banking credit growth. The outcome of this policy is that shadow bank lending responds to monetary policy shocks in the opposite direction of commercial bank lending and as a result reduces the effectiveness of monetary policy. They show that under normal conditions, regular bank credit and shadow bank credit changes pro-cyclically with monetary policy, but when the LDR cap is imposed varies contra-cyclically.

[Enkhbold \(2024\)](#) examined how monetary policy, through the mortgage market concentration channel, transmitted mortgage rates for traditional and shadow banks in the United States from 2009 to 2019. His results show that, on average, shadow and traditional banks have only a small difference in the transmission of monetary shocks to mortgage rates. However, in highly concentrated markets, shadow banks transmit monetary shocks more than traditional banks because they rely on investor funds that react quickly to changes in monetary policy.

[Huang \(2024\)](#) investigated how commercial and shadow banks adjust their mortgage interest rates in response to changes in long-term interest rates. The results of this paper show that both types of banks respond similarly to changes in short-term rates. But shadow banks are significantly more responsive to long-term interest rates than commercial banks. He argues that this difference could be due to the distinct asset sensitivities associated with each type of bank.

[Jiang and Fu \(2025\)](#) examined the differential impact of monetary policy on investment between state-owned enterprises (SOEs) and non-SOEs in China, with respect to the growth of shadow banking. They concluded that policymakers should consider developments in the financial system when assessing the effectiveness of monetary policy. According to their findings, contractionary monetary policy has a significant negative impact on investment by state-owned companies, as these companies rely more on traditional bank loans and are therefore more sensitive to monetary tightening, while non-state-owned companies are largely dependent on the shadow banking sector, which reduces the impact of monetary contraction on them.

A number of research in Iran has examined the mechanisms and determinants of monetary policy transmission. Notable contributions in this area include those of [Komeijani & Alinejad Mehrabani \(2012\)](#), [Bajelan et al., \(2018\)](#), [Kazerooni et al., \(2018\)](#), and [Raei et al., \(2018\)](#). [Zarei et al., \(2021a\)](#) examined the role of shadow banking in the transmission of monetary policy using cross-country data from 2002 to 2018 and the quantile regression and GMM models. Their results show that an increase in the shadow banking index diminishes the effectiveness of monetary policy. Also, [Zarei et al., \(2021b\)](#) examined the impact of shadow banking on the financial stability using data from 14 countries of the G20 during the 2002-2018. They use quantile regression method and divided countries into four groups according to the level of shadow banking activity. Their results indicated that shadow banking has a negative impact on financial stability. Furthermore, an examination of Iran's monetary policy was conducted by [Makipour et al., \(2023\)](#), who utilized the DSGE approach and the model proposed by [Mazelis \(2015\)](#) to

account for shadow banking. Their results show that the presence of shadow banking in the economy reduces the effect of this policy in the case of contractionary monetary policy and promotes its effect in the case of expansionary monetary policy.

A literature review indicates that the importance of shadow banking in Iran's economy and its impact on the effectiveness of monetary policy has been neglected. The only study in this field is the article by [Makipour et al., \(2023\)](#) which used the DSGE method. As mentioned in Section 2, the estimated value of shadow banking assets in their study is very different from the present study. In terms of DSGE modeling, the paper by [Makipour et al., \(2023\)](#) used the [Mazelis \(2015\)](#) model, which itself is a modified version of the [Gertler and Karady \(2011\)](#) model. In fact, the paper by [Gertler and Karady \(2011\)](#) is about Unconventional monetary policy and does not address the issue of shadow banking. However, due to the type of model used, [Mazelis \(2015\)](#) modified this model to examine shadow banking and its relationship with monetary policy. [Makipour et al., \(2023\)](#) used the [Mazelis \(2015\)](#) model in their paper. While in the present paper, the Gertler and Karadi model has been directly modified by the authors in an innovative way based on the conditions of the Iranian economy. The traditional and shadow banking sector in this paper entered into the model by introducing variables and parameters that are different from the article by [Makipour et al., \(2023\)](#). Also, in this article, in addition to the monetary shock of the change in the money growth rate, the nominal interest rate shock is also examined and the effects of this shock on macroeconomic variables are examined. While in the article by [Makipour et al., \(2023\)](#) the interest rate shock is not considered. The results of the present paper are also different from the aforementioned article, which is described in Section 5. Therefore, our study complements [Makipour et al., \(2023\)](#) study and helps to understand how shadow banking affects monetary policy transmission in Iran.

#### 4. Method

In order to investigate the shadow banking effects on the transmission of monetary policy, this article employs the monetary DSGE model under the New Keynesian school that nominal rigidity exists ([Mirjalili, 2015](#)). The conceptual framework for this model was established by [Gertler & Karadi \(2011\)](#). A model was developed by [Gertler & Karadi \(2011\)](#) with the purpose of examining unconventional monetary policy. When traditional channels of monetary policy transmission are weakened, ineffective, or inadequate to accomplish the central bank's objectives, unconventional monetary policy may be implemented ([Mirjalili, 2017](#)). As the argument posited in the theoretical foundations suggests that shadow banking has the potential to undermine the implementation of

monetary policy, shadow banking is in some way associated with unconventional monetary policy. The model proposed by [Gertler & Karadi \(2011\)](#) is utilized in this article with qualification to examine the effects of shadow banking in Iran. In pursuit of this objective, the financial intermediation sector is partitioned into two distinct sectors: conventional banking and shadow banking.

The DSGE model under consideration comprises six agents: 1. Households; 2. Financial intermediaries, comprising two sectors—traditional banking (which is regulated) and shadow banking; 3. Producers of intermediate goods; 4. Producers of capital goods; 5. Retailers; and 6. The government and monetary authority (central bank). The characterizing equations are log-linearized around the steady state and therefore, the shocks to the model and the deviations from the steady state can be interpreted as percentage changes. To presentational purposes, the equations expressed in linear form.

#### 4-1. Households

Continuum of identical households (with identical utility function), in addition to providing labor, households consume products and services and save surplus funds. The surplus funds of households are deposited in either conventional or shadow banking. Every household consists of two individuals: the worker and the banker. Workers are compensated for their labor. Bankers oversee financial intermediaries and distribute their proceeds to households. Therefore, households are owners of financial intermediaries.

At any given time,  $1-f$  of the household members are workers and  $f$  of households are bankers. One may shift from worker to banker over the course of their lifetime. A banker during this period will maintain that occupation for the subsequent period with a  $\theta$  percent probability. Consequently, the average survival for a banker is  $1/(1-\theta)$ . Hence, during each period,  $(1-\theta)f$  of bankers move into the worker. A similar number of workers are also become bankers in a random manner, maintaining a constant ratio of their numbers. The household maximizes the utility function (1):

$$\max E_t \sum_{i=0}^{\infty} \beta^i \left[ \ln(C_t(t+i) - hC_t(t+i-1)) - \chi \right] / (1+\phi) \quad (1)$$

Where  $C$  denotes consumption and  $L$  denotes labor supply. The equation incorporates parameters  $\beta$  and  $h$  to discount factor and habits, respectively. These parameters have values ranging from zero to one. The parameter  $\phi$  represents the inverse Frisch labor supply elasticity and  $\chi$  is the relative utility weight of labor, whose value is greater than zero.

From period  $t-1$  to  $t$ , both traditional (conventional) and shadow banking institutions pay interest to their deposits ( $B$ ). Hence, for the purpose of optimizing their utility, households are constrained by the budget constraint represented by Equation 2:

$$C_t = w_t L_t + \Pi_t - T_t + R_t^b B_t^b + R_t^{sb} B_t^{sb} - B_{t+1} \quad (2)$$

Where  $T$  denotes tax,  $W$  represents wage rate, and  $\Pi$  denotes profits to the household from both financial firms (traditional and shadow banks) and non-financial firms.  $B$  represents the aggregate amount of household savings held as deposits with both conventional and shadow banking institutions.  $B_t^b$  denotes the savings held by households with conventional banks, while  $B_t^{sb}$  represents their savings with shadow banking. Additionally,  $R_t^b$  and  $R_t^{sb}$  denote gross interest rate paid on deposits in conventional and shadow banks, respectively. Consequently, the sum of the household's savings will be  $B_t^T = B_t^b + B_t^{sb}$ . The average interest rate of conventional and shadow banks, denoted as  $R^w$ , can be expressed as follows:

$$R_t^b B_t^b + R_t^{sb} B_t^{sb} = R_t^w B_t^T \quad (3)$$

The marginal utility of consumption  $q_t$ , denoted as  $dU / [dC]_t$ , can be obtained by constructing the Lagrange function and implementing the first order condition:

$$[q_t = (C_t - h(C_{t-1}))]^{-(1)} - \beta h E_t (C_{t+1} - h(C_t))^{-(1)} \quad (4)$$

$$1 = \beta E_t \Lambda_{t,t+1} R_{t+1}^w \quad \Lambda_{t,t+1} = ([q_{t+1}]^{-(1)} - [q_t]^{-(1)}) / ([q_t]^{-(1)} - [q_{t-1}]^{-(1)}) \quad (5)$$

$$W_t = \chi [L_t]^\varphi / q_t \quad (6)$$

## 4-2. Financial Intermediaries

### a) Traditional Banks

The funds collected from households are lent by banks to non-financial businesses. In period  $t$ , the wealth (net worth) of bank  $j$  is denoted as  $N_{jt}$ . If  $B_{j,t+1}$  represents household deposits with bank  $j$ , and  $S_j$  represents the bank's portfolio of lending, the resulting balance sheet for bank  $j$  would be as follows:

$$Q_t S_{jt} = N_{jt} + B_{j,t+1} \quad (7)$$

Where the price of each unit of loan portfolio is denoted by  $Q_t$ . As previously stated, banks earn return  $R_{t+1}$  from lending and pay gross return  $R_{t+1}$  on deposits during period  $t+1$ . The net worth of a bank consequently evolves according to Equation 8.

$$N_{j,t+1} = R_{t+1} Q_t S_{jt} - R_{t+1} B_{j,t+1} = (R_{t+1} - R_{t+1}^b) Q_t S_{jt} + [R_{t+1} - R_{t+1}^b] N_{jt} \quad (8)$$

Hence, the interest spread (difference between the interest rate paid and received ( $R_{(kt+1)} - R_{(t+1)}$ )) determines the growth of equity.

The banker maximizes their expected terminal net worth  $V_t$  and distributes all accumulated profits to their household prior to exit the industry. This is achieved through Equation 9:

$$V_{jt} = \left[ \max_{\{f_0\}} E \right]_t \sum_{i=0}^{\infty} \left[ (1-\theta) \theta^i \beta^{i+1} \Lambda_{(t,t+1+i)} \right] N_{(jt+1+i)} = \left[ \max_{\{f_0\}} E \right]_t \sum_{i=0}^{\infty} \left[ (1-\theta) \theta^i \beta^{i+1} \Lambda_{(t,t+1+i)} \right] [(R_{(kt+1)} - R_{(t+1)}) Q_t S_{jt} + [R_{(t+1)} N]_{jt}] \quad (9)$$

So far as the return on loans ( $R_{(kt+1)}$ ) exceeds the interest paid to deposits ( $R_{(t+1)}$ ), banks have a propensity to increase their asset base through more borrowing from households and further lending. In order to curtail this capability, the central bank implements lending restrictions, including the capital adequacy ratio. It is postulated that every period the banker diverts the fraction  $\lambda$  of loan portfolio from the project and then transfer them back to the household and the bank's depositors are not able to recover; consequently, they are authorized to lend  $1-\lambda$  of the deposits. Failure to adhere to this regulation may result in the banker incurring a penalty from the central bank or potentially facing insolvency. Thus, the subsequent equation needs to be established prior to depositors being inclined to deposit in bank  $j$ :

$$V_t \geq \lambda Q_t S_{jt} \quad (10)$$

Rewriting Equation 9 as follows is possible by implementing this restriction:

$$V_{jt} = v_t Q_t S_{jt} + \eta_t N_{jt} \quad (11)$$

$$v_t = E_t [(1-\theta) \beta \Lambda_{(t,t+1)} (R_{(kt+1)} - R_{(t+1)}) + \beta \Lambda_{(t,t+1)} \theta x_{(t,t+1)} v_{(t+1)}] \quad (12)$$

$$\eta_t = E_t [(1-\theta) + \beta \Lambda_{(t,t+1)} z_{(t,t+1)} \theta \eta_{(t+1)}] \quad (13)$$

Where  $\eta_t$  represents the expected discounted value of an additional unit of  $N_j$ , while  $v_t$  signifies the expected discounted value of expanding assets. In addition, the gross growth rate of net worth of bank  $j$  is denoted by  $z_{(t,t+1)}$  and the gross asset growth rate (loan portfolio value) is represented by  $x_{(t,t+1)}$  using the following equations:

$$x_{(t,t+1)} = (Q_{(t+1)} S_{(jt+1)}) / (Q_t S_{jt}) \quad (14)$$

$$z_{(t,t+1)} = N_{(jt+1)} / N_{jt} \quad (15)$$

Consequently, we can rewrite Equation 10 as follows:

$$v_t Q_t S_{jt} + \eta_t N_{jt} \geq \lambda Q_t S_{jt} \quad (16)$$

If this restriction is upheld, then the assets the bankers can acquire depends positively to their equity capital.

$$Q_t S_{jt} = \eta_t / (\lambda_t - v_t) N_{jt} = \phi_t N_{jt} \quad (17)$$

The (private) leverage ratio, denoted by  $\phi$  in this equation, represents the private assets to equity ratio. Equation 18 provides an expression for the progression of the banker's net worth.

$$N_{jt+1} = [(R_{kt+1} - R_{t+1}) \phi_t + R_{t+1}] N_{jt} \quad (18)$$

The values of  $x_{t,t+1}$  and  $z_{t,t+1}$  are thereby reformulated according to the subsequent equations:

$$z_{t,t+1} = N_{jt+1} / N_{jt} = [(R_{kt+1} - R_{t+1}) \phi_t + R_{t+1}] \quad (19)$$

$$x_{t,t+1} = (Q_{t+1} S_{t+1}) / (Q_t S_t) = (\phi_{t+1} N_{jt+1}) / [\phi_t N_{jt}] = \phi_{t+1} / \phi_t \quad (20)$$

Since the constituents of  $\phi_t$  are not contingent upon the particular attributes of the firm, the following individual demands can be added together to ascertain the total demand for bank assets:

$$[Q_t S_t] = \phi_t N_t \quad (21)$$

A fraction  $f(1-\theta)$  of bankers exit and allocate the accumulated profits among their households during each period. A similar process occurs whereby bankers are appointed to workers at random, ensuring that the proportion of bankers remains constant. The following outcome will result from denoting the net worth of new banks as  $N_{nt}$  and the net worth of existing banks as  $N_{et}$ :

$$N_t = N_{et} + N_{nt} \quad (22)$$

The households transfer the ratio  $\omega(1-\theta)$  of their asset values to new banks during each period. Therefore, the net asset value of new banks compared to existing banks is ascertained by Equations 23 and 24:

$$N_{et} = [\theta [(R_{kt} - R_t) \phi_{t-1} + R_t] [-N_{t-1}]] \quad (23)$$

$$N_{nt} = \omega Q_t S_{t-1} \quad (24)$$

Where  $\omega$  is the parameter used to determine the steady state  $\phi$ .

## b) Shadow Banking

As stated in the preceding section, this model divides the financial intermediations into two distinct sections: conventional banking and shadow banking. To clarify, the aggregate amount of lending in the financial system ( $Q_t S_t$ ) is calculated by adding the following: traditional banking lending ( $Q_t S_t^b$ ) and shadow lending ( $Q_t S_t^{sb}$ ):

$$Q_t S_t = Q_t S_t^b + Q_t S_t^{sb} \quad (25)$$

In contrast to conventional banking institutions, which are subject to limitations on lending, shadow banking operates without such constraints and are not face with tight central bank regulations, such as the capital adequacy ratio.

It is assumed that shadow banking accounts for  $\psi_t$  percent of financial intermediation (lending) during period  $t$ . Therefore, Equation 25 can be expressed as follows:

$$Q_t S_t^* = \phi_t N_t + \psi_t Q_t S_t^* = \phi_{ct} N_t \quad (26)$$

Where the leverage ratio of traditional banks is denoted by  $\phi_t$ , while the leverage ratio of all financial intermediaries (both shadow and traditional) is represented by  $\phi_{ct}$ . The equation can be expressed as follows:

$$\phi_{ct} = 1/(1-\psi_t) \phi_t \quad (27)$$

Gertler & Karadi (2011) state that the variable  $\psi_t$  is determined using Equation 28:

$$\psi_t = \psi + v E_t [ ((\log R)_{t+1} - (-\log R)_{t+1}) - ((\log R)_k - (-\log R)_k) ] \quad (28)$$

Where  $\psi$  is the percentage of shadow intermediation in the steady state.

#### 4-3. Intermediate goods firms

A producer of intermediate goods is a non-financial firm that sells intermediate goods to retailers and operates under perfect competition. The firm grants capital  $K_{t+1}$  at the end of period  $t$  for utilization in the production process of the subsequent period. The firm is permitted to sell its capital in the market at the of period  $t+1$ . As there are no adjustment costs, capital choice problem of the firm remains static. Firm's capital is provided by borrowing from financial intermediaries, including both shadow and traditional banking. Due to the fact that the return of financial sector operations is distributed as profit to shareholders, the firm's profit is zero. Thus, the total capital of firms is equivalent to the aggregate amount of lending by both traditional and shadow banking institutions.

$$Q_t K_{t+1} = [Q_t S_t] \quad (29)$$

The firm produces output  $Y$  in each period by utilizing labor  $L$  and capital  $K$ . Equation 30 provides the output when total factor productivity (technology factor) is denoted by  $A$ , the rate of capital utilization is denoted by  $U$ , and the quality of capital is denoted by  $\xi$  (so  $\xi K$  is effective capital utilization):

$$Y_t = A_t ( [U_t \xi_t K]_t )^\alpha L_t^{1-\alpha} \quad (30)$$

$P_{mt}$  denotes the price of intermediate goods produced by the firm. Also, the replacement price of capital utilized in each unit remains constant. Firms encounter the constraint of funds provided by financial intermediaries (capital) for manufacturing purposes. Thus, the firm maximizes its profits using Equation 31:

$$K(K_{t+1}, L_t) = \beta \max_{\xi_t} \left[ E_t \sum_{i=0}^{\infty} \beta^i \Lambda_{t,t+1} \right] [P_{mt} Y_{t+(Q_t-\delta)} U_t \xi_t K_t - W_t L_t - R_{kt} K_t Q_{t-1}] \quad (31)$$

While there is no profit for the firm, it pays capital return to the banks. Given  $E_t \beta \Lambda_{t,t+1}$  by  $\Psi$  ( $E_t \beta \Lambda_{t,t+1} = \Psi$ ) and according to equation 30, we can solve the first-order condition as below:

$$(dK(K_{t+1}, L_t)) / (dK_t) = \Psi P_{mt+1} \alpha A_{t+1} \xi_{t+1} [U_{t+1} (U_{t+1} \xi_{t+1} K_{t+1})]^{\alpha-1} [L_{t+1}]^{1-\alpha} + \Psi (Q_t - \delta) U_t \xi_{t+1} - \Psi R_{kt+1} Q_t = 0 \quad (32)$$

$$R_{kt+1} Q_t = P_{mt+1} \alpha Y_{t+1} / K_{t+1} + (Q_{t+1} - \delta) U_{t+1} \xi_{t+1} \quad (33)$$

To determine  $R_{kt+1}$ , we can rewrite equation 33 as equation 34:

$$R_{kt+1} = ([P_{mt+1} \alpha Y_{t+1} / \xi_t K_t]_{t+1} + (Q_{t+1} - \delta) U_{t+1} \xi_{t+1}) / Q_t \quad (34)$$

With optimization and consideration of capital constraints, the capital utilization rate and labor demand of the firms during period  $t$  can be stated as Equations 35 and 36 respectively:

$$P_{mt} \alpha Y_t / U_t = \delta' (U_t) \xi_t K_t \quad (35)$$

$$P_{mt} (1-\alpha) Y_t / L_t = W_t \quad (36)$$

The residual capital stock is quantified as  $Q_{t+1} - \delta (U_{t+1} \xi_{t+1} K_{t+1})$ . The  $\xi_{t+1}$  shock provides the source of volatility in capital returns. Furthermore, the current value of the asset is typically depending on the expected future path of  $\xi_{t+1}$ .

#### 4-4. Capital Producers

At the end of period  $t$ , capital producing firms purchases capital from producers of intermediate goods and proceeds to manufacture and build new capital goods subsequent to repairs and renovations. The replacement cost of capital that has been depreciated is equal to 1. the cost of new capital is  $Q_t$ . No adjustment costs are associated with refurbishing capital, whereas the production of new capital incurs an adjustment cost. Assumptions underlying the model posit that households hold ownership of the capital and are entitled to accrue interest on it.

The net capital created can be expressed as Equation 37, where  $I_t$  represents the gross capital produced:

$$I_{nt} = I_t - \delta (U_t \xi_t K_t) \quad (37)$$

When  $I_{ss}$  denotes the steady state of investment, the discounted profit of the capital goods producer is derived by maximizing Equation 38 subject to Equation 39:

$$[I_{nt}] = \max_{I_{nt}} E_t \sum_{\tau=t}^{\infty} \beta^{\tau-t} \Lambda_{\tau} [(Q_{\tau-1} I_{nt} - f((I_{nt} + I_{ss})/(I_{nt-1} + I_{ss}))(I_{nt} + I_{ss}))] \quad (38)$$

$$[s.t. I_{nt} = I(t) - \delta(U_t) \xi_t K_t] \quad (39)$$

Where  $f(1) = f'(1) = 0$  and  $f''(1) > 0$ .  $I_{nt}$  denote specific shocks,  $I_{ss}$  denotes the steady state of investment and  $\delta(U_t) \xi_t K_t$  shows the value of capital replacement. The first-order condition for the price  $Q_t$  is given by the derivative of 38 equations with respect to  $I_{nt}$  (see Gertler and Karadi, 2011). To solve it, we can expand equation 38 as follows:

$$[I_{nt}] = \max_{I_{nt}} E_t [(Q_t - 1) I_{nt} - f((I_{nt} + I_{ss})/(I_{nt-1} + I_{ss}))(I_{nt} + I_{ss})] + E_t \beta \Lambda_{t,t+1} [(Q_{t+1} - 1) I_{nt} - f((I_{nt+1} + I_{ss})/(I_{nt} + I_{ss}))(I_{nt+1} + I_{ss})] + \dots \quad (40)$$

Since the third and subsequent sentences do not include the term  $I_{nt}$ , then their derivative is zero with respect to this variable. Denoting  $f((I_{nt} + I_{ss})/(I_{nt-1} + I_{ss}))$  by  $f(\cdot)$  and  $E_t \beta \Lambda_{t,t+1}$  by  $\Psi$  the first order condition is:

$$Q_t - 1 - f'(\cdot) / (I_{nt-1} + I_{ss}) (I_{nt} + I_{ss}) - f(\cdot) - \Psi f'(\cdot) ((I_{nt+1} + I_{ss})/(I_{nt} + I_{ss}))^2 = 0 \quad (41)$$

$Q_t$  is obtained by solving this equation:

It produces the subsequent relationship for  $Q_t$ :

$$Q_t = 1 + f'(\cdot) (I_{nt} + I_{ss}) / (I_{nt-1} + I_{ss}) - f'(\cdot) - E_t \beta \Lambda_{t,t+1} (((I_{nt+1} + I_{ss}) / (I_{nt} + I_{ss}))^2 f'(\cdot)) \quad (42)$$

#### 4-5. Retailers

These firms buy intermediate goods from the producer at the price of  $P_{mt}$  and produce final goods. The final good  $Y_t$  is a CES combination of differentiated retail firms, that using intermediate goods (as the input), produce the final good by Equation 43:

$$Y_t = [\int_0^1 Y_{ft}^{(\varepsilon-1)/\varepsilon} df]^{1/(\varepsilon-1)} \quad (43)$$

Where  $Y_{ft}$  is the produced goods by firm  $f$ . The parameter  $\varepsilon$  is the elasticity of substitution between goods. By minimizing the cost by consumer of the final product Equations 44 and 45 are as follows:

$$Y_{ft} = (P_{ft}/P_t)^{-\varepsilon} Y_t \quad (44)$$

$$P_t = [\int_0^1 P_{ft}^{1-\varepsilon} df]^{1/(1-\varepsilon)} \quad (45)$$

In fact, the firm producing the final product needs a unit of intermediary goods to produce a unit of output. Therefore, the final cost of these firms is equal to the relative price of the intermediate good  $P_{mt}$ . The nominal rigidity of prices is included in the model in such a way that in each period the firm can adjust prices with a probability of  $\gamma-1$ . These firms determine the optimal price  $P_t^*$  by solving the following equation:

$$\left[ \max_{\pi_t} \right] \left[ E_t \sum_{i=0}^{\infty} \beta^i \Lambda_{t,t+i} \left[ \frac{P_t^*}{P_{t+i}} \right] \prod_{k=1}^i (1 + \pi_{t+k-1})^{\gamma_p} - P_{t+i} \right] Y_{t+i} \quad (46)$$

Where  $\pi_t$  is the inflation rate of period  $t-1$  to period  $t$ . The first order condition gives the Equation 47.

$$\sum_{i=0}^{\infty} \beta^i \Lambda_{t,t+i} \left[ \frac{P_t^*}{P_{t+i}} \right] \prod_{k=1}^i (1 + \pi_{t+k-1})^{\gamma_p} - \mu P_{t+i} \right] Y_{t+i} = 0 \quad (47)$$

In this regard, the  $\mu$  parameter is equal to:

$$\mu = \epsilon / (\epsilon - 1) \quad (48)$$

Using the law of large numbers, equation (49) is obtained to determine the change in the price level:

$$P_t = [(1 - \gamma) (P_t^*)^{1-\epsilon} + \gamma (\Pi_{t-1})^{\gamma_p} P_{t-1}]^{1/(1-\epsilon)} \quad (49)$$

#### 4-6. Government and Monetary Authority

It is assumed based on the findings of Keshavarz's (2018) that the government finances its expenditures by oil export revenues, money creation, and taxation. Therefore, the government budget constraint is as follows:

$$G_t = O_t + T_t + (M_t - M_{t-1}) / P_t \quad (50)$$

Where  $G_t$  and  $O_t$  follow the AR(1) process:

$$G_t = (1 - \rho_g) G_{ss} + \rho_g G_{t-1} + \varepsilon_t^g$$

$$O_t = \rho_o O_{t-1} + \varepsilon_t^o$$

Monetary policy is typically established in DSGE models by the Taylor rule. However, in the majority of domestic studies that have applied the DSGE model to Iran's economy, this rule has been deemed invalid in light of the circumstances governing Iran's economy and the mandatory interest rate determination. As a result, alternative methods have been utilized for the monetary policy rule. Typically, the money growth rate is incorporated as a policy variable in such analyses.

The framework for targeting inflation, which the Central Bank of Iran implemented by June 2020, places emphasis on the market's role in determining the exchange rate. In pursuit of this objective, the central bank has implemented open market operations as its primary mechanism, with interbank market interest rates serving as one of the instruments to accomplish this.

In light of this and in accordance with the Central Bank of Iran's new guidelines, the monetary policy rule in the current model is regarded as a straightforward Taylor rule. Although some studies (like: [Chenarani et al., 2023](#)) have used Taylor rule for Iran's economy. But so as to be more compatible with Iranian economic conditions, as stated in [Farzinvasht et al., \(2014\)](#), parameters related to the dependence of interest rates to output-

inflation gap being considered as below normal level. Because the interest rate in Iran is largely determined mandatory and has less dependence on the output-inflation gap (as stated in the Taylor rule). Therefore, the monetary policy rule is mathematically expressed as Equation 51:

$$i_t = i_{t-1}^\rho \left( \frac{1}{\beta} \pi_t^{\kappa_\pi} \right) \left( \frac{1}{P} \mu \right)^{\kappa_y} (1-\rho) e_i \quad (51)$$

Where  $e_i$  denotes the interest rate shock. Moreover, given Iran's economy, it seems that, the money growth rate be considered as a policy rule. Alternatively, monetary policy can be implemented through the regulation of the nominal growth rate of money. The money supply growth rate is determined by an AR (1) process:

$$\dot{M}_t = \rho_m [\dot{M}_{t-1} + (1-\rho_m)(\dot{M}_t)^* + \rho_m \varepsilon_{t^m}] \quad (52)$$

Fisher's equation is defined as follows:

$$1+i_t = R_{t+1} E_t ( [1+\pi]_{t+1} ) \quad (53)$$

The market clear condition is ultimately illustrated as follows:

$$Y_t = C_t + I_t + G_t \quad (54)$$

## 5. Model Analysis and Results

Most of the structural parameters utilized in this study are taken from [Gertler & Karadi \(2011\)](#). The value of some parameters has been adjusted based on the structure of Iran's economy. For example, the steady state ratio of government spending to GDP is considered to be 0.12 instead of 0.2 based on research calculations. The values of the parameters are presented in Table 1.

Table 1. Model parameters

| Symbol      | Value | Description                                   | Source            |
|-------------|-------|-----------------------------------------------|-------------------|
| Households  |       |                                               |                   |
| $\beta$     | 0.990 | Discount rate                                 | GK (2011)         |
| $h$         | 0.815 | Habit                                         | GK (2011)         |
| $\chi^{HH}$ | 3.409 | Relative utility weight of labor              | GK (2011)         |
| $\varphi$   | 0.276 | Inverse Frisch elasticity of labor supply     | GK (2011)         |
| Banks       |       |                                               |                   |
| $\lambda$   | 0.381 | Fraction of bank assets that can be diverted  | GK (2011)         |
| $\omega$    | 0.002 | Proportional transfer to the incoming banks   | GK (2011)         |
| $\theta$    | 0.972 | Survival rate of a banker                     | GK (2011)         |
| $v$         | 400   | The leverage ratio parameter for shadow banks | Model calibration |

| Symbol          | Value | Description                                        | Source                |
|-----------------|-------|----------------------------------------------------|-----------------------|
| Goods Producers |       |                                                    |                       |
| $\alpha$        | 0.330 | Effective capital share                            | GK (2011)             |
| $\delta$        | 0.025 | Depreciation rate                                  | GK (2011)             |
| $\epsilon$      | 4.167 | Elasticity of substitution                         | GK (2011)             |
| $\gamma$        | 0.779 | Probability of keeping prices fixed                | GK (2011)             |
| $\gamma_p$      | 0.241 | Price indexation                                   | GK (2011)             |
| $\eta$          | 1.728 | Elasticity of investment adjustment cost           | GK (2011)             |
| Government      |       |                                                    |                       |
| $G/Y$           | 0.12  | Steady state proportion of government expenditures | Research calculations |
| $\kappa_\pi$    | 1.1   | Inflation coefficient of Taylor rule               | Model calibration     |
| $\kappa_y$      | 0.1   | Output gap coefficient of Taylor rule              | Model calibration     |
| $\rho_i$        | 0.8   | Smoothing parameter of the Taylor rule             | GK (2011)             |

To assess the impact of shadow banking on monetary policy effectiveness, we analyzed two distinct scenarios: one without shadow banking and another incorporating shadow banking. These scenarios were used to evaluate how policy shocks—specifically changes in interest rates and money growth—affect key real variables (investment and output) as well as the inflation rate. The results are presented in Figures 4 and 5. Since the model is log-linearized, both the shocks and the deviations from the steady state can be interpreted as percentage changes.

### 5-1. Negative Money Growth Rate Shock

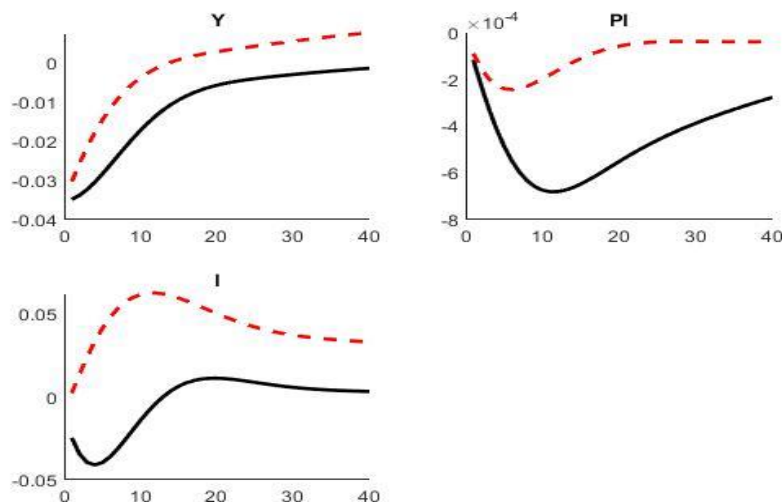


Fig. 4: Macroeconomic variables responses to a negative money growth rate shock.

Figure 4 illustrates the dynamic responses of output, investment, and inflation to a 5% contractionary money growth rate shock, comparing two scenarios: one without shadow banking (solid black curve) and another with shadow banking (dotted red curve).

#### 5-1-1. Baseline Scenario (Without Shadow Banking)

As expected, the contractionary policy (decreasing money supply growth) leading to declines in investment, aggregate demand, and output. Because this policy reduces bank lending capacity, thereby reducing the investment expenditures of enterprises and household consumption costs via the credit channel. As aggregate demand declines, the output will also decrease. With a five percent negative shock to money supply growth:

Output drops by 0.035% from its steady state, persisting for 40 periods. Investment initially falls by 0.045% but fully recovers after 19 periods. Inflation declines steadily until the 10th period, remaining below the steady state thereafter. These results align with conventional monetary transmission theories, where reduced credit availability suppresses economic activity.

#### 5-1-2. Shadow Banking Scenario

When shadow banking is introduced, the model results reveal significant deviations from the baseline due to the unregulated nature of shadow credit intermediation. Unlike in the baseline, investment rises by 0.07% (peaking at the 10th period) before gradually declining—yet never fully reverting to steady-state levels. This reflects credit substitution: as traditional bank lending contracts, firms and households turn to shadow banks for financing, offsetting part of the credit reduction. Indeed, when the lending capacity of traditional banks decreases, households and small and medium-sized enterprise (SMEs) are unable to secure financing through alternative means (e.g., issuing shares or bonds), they resort to the riskier practice of shadow banking. In this way, a portion of the credit reduction in conventional banks is offset.

In this scenario output still falls, but the decline is smaller than in the baseline, and the effect dissipates after just 11 periods (versus 40 in Baseline Scenario). The attenuation stems from partial credit replacement by shadow banks, though reduced government spending and consumption still weigh on aggregate demand. Inflation drops by only 2% (versus 7% in the baseline), with effects vanishing almost immediately. This suggests shadow banking dampens monetary policy's price-stabilizing effectiveness, as unregulated credit softens demand-side pressures.

This finding supports Mazelis (2015) and Le *et al.*, (2022), highlighting the divergent lending behaviors of shadow and traditional banks under monetary shocks.

## 5-2. Positive Interest Rate Shock

The response of economic variables to a contractionary policy involving a positive interest rate shock is depicted in figure 5.

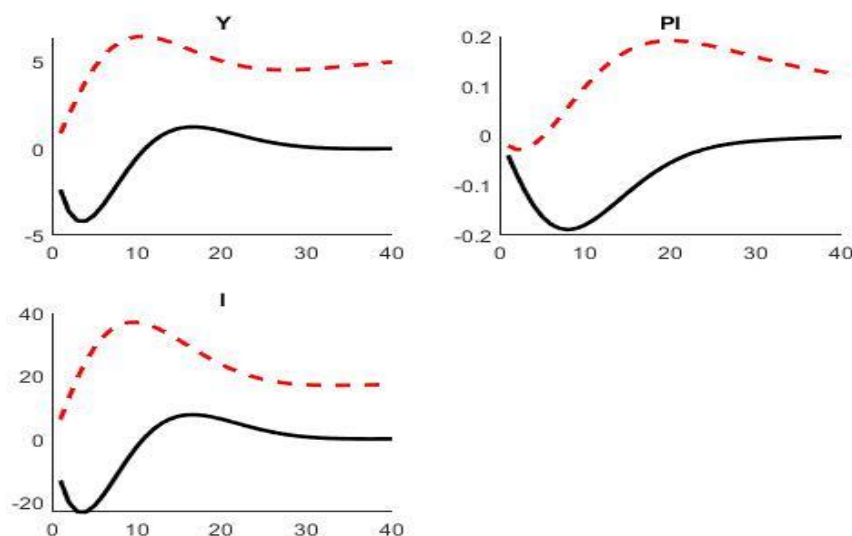


Fig. 5: Macroeconomic variables responses to a positive interest rate shock

### 5-2-1. Baseline Scenario (Without Shadow Banking)

According to these findings, in the first scenario (without shadow banking), the response of investment and output to an interest rate shock is consistent with expectations. Consistent with standard economic theory, a 5% positive interest rate shock leads to output Decline. As a result of this policy output falls immediately, reaching 5% below steady state within 2 periods, and recovers after 20 periods. The response of investment to this shock is stronger than that of output. Investment declines sharply by 20% below steady state (also within 2 periods), reflecting higher sensitivity to borrowing costs. Inflation decreases by 0.2% with a 9-period lag, aligning with conventional monetary policy transmission. These results confirm that higher interest rates suppress economic activity by raising borrowing costs, reducing demand, and dampening price pressures—a typical channel of monetary tightening.

### 5-2-2. Shadow Banking Scenario

When shadow banking is introduced, the dynamics deviate sharply from expectations. In case of contractionary policy of raising interest rate, instead of declining, both output and investment increase in response to rising interest rates. Shadow banks—unconstrained by regulatory or interest rate policies—expand lending to offset the contraction in traditional bank credit. Their ability to outpace the decline in conventional lending creates a net increase in available credit.

In response to the interest rate shock, output immediately begins to increase and reaches a maximum after 11 periods (7% increase from the steady state). This increase is persistent and never returns to the steady state level. The impact of this shock on investment is greater than on output, with an increase of 40% after 10 periods.

Inflation rises by 0.2% indefinitely, contrasting with the disinflationary effect in the baseline model. This suggests shadow banking counteracts central bank tightening, as easier credit access sustains demand-side price pressures.

The findings of this study provide support for the hypothesis that shadow banking mitigates the impact of monetary policy on macroeconomic variables. These findings underscore the need for policymakers to account for shadow banking's growing role in credit markets when designing and implementing monetary measures.

## 6. Conclusion

This study examined the impact of shadow banking on monetary policy transmission in Iran using a DSGE framework. By analyzing two scenarios—one excluding and another incorporating shadow banking—we assessed how monetary policy shocks (a reduction in money supply growth and an increase in interest rates) affect key macroeconomic variables: output, investment, and inflation. Our findings reveal that shadow banking significantly diminishes the effectiveness of monetary policy, altering both the magnitude and direction of policy impacts.

With a money supply contraction, in the scenario without shadow banking, a reduction in money supply growth led to declines in investment, output, and inflation, consistent with conventional monetary theory. With shadow banking scenario, Investment paradoxically increased, as shadow banks compensated for—and even surpassed—the reduction in traditional bank lending. Also, the effects on output and inflation were weaker, with smaller deviations from steady-state levels compared to the baseline scenario.

In the case of positive interest rate shock, in the absence of shadow banking, higher interest rates reduced output and investment, with inflation declining as expected. In this

case, the output and investment variables experience a negative deviation from their steady state values and subsequently decline. Additionally, the effects of this stimulus diminish after approximately 10 periods, and they revert back to their steady state value.

However, shadow banking not only undermine the impacts of this policy but also adversely effects on investment and output in comparison to the traditional banks. Investment and output rose in response to the interest rate shock, as unregulated shadow credit offset the contraction in traditional lending. Inflation increased permanently, contradicting the disinflationary outcome of the baseline model.

The results demonstrate that shadow banking undermines monetary policy transmission by: 1- Blunting investment and output responses through alternative credit channels; 2- Shortening the duration of policy effects; 3- Reducing inflation control efficacy, complicating central banks' stabilization efforts.

These results highlight a critical challenge for Iranian policymakers:

Shadow banking undermines monetary control by blunting or reversing policy transmission mechanisms.

Stricter regulations on traditional banks could inadvertently expand shadow banking activity, further eroding policy efficacy.

Policymakers must account for non-bank intermediation when designing measures, as ignoring its role risks unintended consequences.

### **Acknowledgments**

The authors extend their sincere gratitude to the anonymous peer reviewers for their insightful critiques and constructive suggestions, which significantly enhanced the clarity and scholarly rigor of this manuscript.

### **Authors' contributions**

This research is derived from the first author's doctoral dissertation. The primary data collection, encompassing all observational and analytical components, was conducted by the first author under the direct supervision and mentorship of the second and third authors.

### **Conflicts of interest**

The authors declare no conflict of interest. This study received no financial support from any organization.

## References

- Adrian, T. & Shin, H. S., (2008). *Financial intermediaries, financial stability, and monetary policy*. FRB of New York staff report, (346).  
<https://doi.org/10.2139/ssrn.1266714>
- Adrian, T. & Shin, H. S., (2009). *The shadow banking system: implications for financial regulation*. FRB of New York Staff Report, (382).  
<https://doi.org/10.2139/ssrn.1441324>
- Agarwal, I., Hu, M. & Zheng, K., (2022). "Lending by Servicing: How Shadow Banks Dampen Monetary Policy Transmission". Available at SSRN.  
<https://doi.org/10.21799/frbp.wp.2023.14>
- Arabian Mahdi, A., Khosravinejad, A. A., Pedram, M., Nazarian, R. & Mohammadi, T., (2020). "Assessment of Credit Channel on Output During Recession and Boom Period in Iran's Economy". *Journal of Applied Economics Studies in Iran*, 9(33): 31-55.  
<https://doi.org/10.22084/aes.2019.18333.2815> (In Persian).
- Arbab Afzali, M., Shahchera, M. & Taheri, M., (2015). *Macro-mapping of the Shadow banking in Iran*. Monetary and Banking Research Institute, Central Bank of the Islamic Republic of Iran, Report MBRI-PN-94022. (In Persian).
- Bajelan, A. A., Bayat, R. & Ansari Samani, H., (2018). "The Role of Financial Development in the Effectiveness of Monetary Policy during Business Cycles: An Application of Markov-Switching Model", *Economic Research and Perspectives*, 18(4):  
[https://ecor.modares.ac.ir/article\\_13417.html?lang=en](https://ecor.modares.ac.ir/article_13417.html?lang=en) (In Persian).
- Ban, C. & Gabor, D., (2016). "The political economy of shadow banking". *Review of international political economy*, 23(6): 901-914.  
<https://doi.org/10.1080/09692290.2016.1264442>
- Bernanke, B. S. & Gertler, M., (1995). "Inside the black box: the credit channel of monetary policy transmission". *Journal of Economic perspectives*, 9(4): 27-48.  
<https://doi.org/10.1257/jep.9.4.27>
- Chen, K., Ren, J. & Zha, T., (2018). "The nexus of monetary policy and shadow banking in China". *American Economic Review*, 108(12): 3891-3936.  
<https://doi.org/10.1257/aer.20170133>
- Chenarani, H., Yavari, K., Heydari, H. & Sharifzadeh, M., (2023). "The Effect of Banking Crises on Macroeconomic Variables Within the DSGE Models Framework". *Journal of Applied Economics Studies in Iran*, 12(46): 9-38.  
<https://doi.org/10.22084/aes.2021.25066.3359> (In Persian).

- Cheng, X. & Wang, Y., (2022). "Shadow banking and the bank lending channel of monetary policy in China". *Journal of International Money and Finance*, 128, 102710. <https://doi.org/10.1016/j.jimonfin.2022.102710>
- De Bondt, G. J., (1999). *Financial structure and monetary transmission in Europe: a cross-country study*. PhD thesis, University of Amsterdam, Faculty of Economics and Business. <https://doi.org/10.4337/9781782542759>
- Enkhbold, A., (2024). *Monetary policy transmission through shadow and traditional banks*. Bank of Canada Staff Working Paper, (No. 2024-8).
- Fisher, E. A. & Bernardo, J., (2014). "The political economy of shadow banking: Debt, finance, and distributive politics under a Kalecki-Goodwin-Minsky SFC framework". *Levy Economics Institute of Bard College Working Paper*, (801). <https://dx.doi.org/10.2139/ssrn.2439884>
- Farzin Vash, A., Ehsani, M. A. & Keshavarz, H., (2014). "Financial Shocks and Labour Market Fluctuations with Financial Frictions". *Iranian Journal of Economic Research*, 19(59): 1-37. [https://ijer.atu.ac.ir/article\\_1402.html?lang=en](https://ijer.atu.ac.ir/article_1402.html?lang=en) (In Persian).
- Financial Stability Board, F.S.B., (2011). *Shadow banking: Scoping the issues. A background note of the financial stability board*, 12 April.
- Friedman, M. & Schwartz, A. J., (1965). "Money and business cycles". In *The state of monetary economics*: 32-78. <https://www.nber.org/system/files/chapters/c5179/c5179.pdf>
- Funke, M., Mihaylovski, P. & Zhu, H., (2015). *Monetary policy transmission in China: A DSGE model with parallel shadow banking and interest rate control*. Hong Kong Institute for Monetary and Financial Research (HKIMR) Research Paper WP No. 12/2015. <http://dx.doi.org/10.2139/ssrn.2605304>
- Gertler, M. & Karadi, P., (2011). "A model of unconventional monetary policy". *Journal of monetary Economics*, 58(1): 17-34. <https://doi.org/10.1016/j.jmoneco.2010.10.004>
- Gong, X. L., Xiong, X. & Zhang, W., (2021). "Shadow banking, monetary policy and systemic risk". *Applied Economics*, 53(14): 1672-1693. <https://doi.org/10.1080/00036846.2020.1841088>
- Huang, J., (2018). "Banking and shadow banking". *Journal of Economic Theory*, 178: 124-152. <https://doi.org/10.1016/j.jet.2018.09.003>
- Huang, H., (2024). "The Shadow Banking Channel of Long-Term Interest Rate Transmission". Available at SSRN 5043960. <https://dx.doi.org/10.2139/ssrn.5043960>

- Jiang, B. & Fu, L., (2025). "Corporate investment and shadow banking channel of monetary policy". *Emerging Markets Review*, 67: 101291. <https://doi.org/10.1016/j.ememar.2025.101291>
- Kazerooni, A., Salahesh, T. & Asgharpur, H., (2018). "Banks' role in Monetary Policy Transmission Mechanism (Emphasis on Balance-Sheet and Financial Health Characteristics of Banks)". *Journal of Economic Research*, 53(1): 69-92. <https://doi.org/10.22059/jte.2017.232209.1007571> (In Persian).
- Keshavarz, h., (2018). "Monetary policy in a financial accelerator models with sticky price and wage". *Journal of applied economics studies in Iran*, 7(25): 227-247. [https://aes.basu.ac.ir/article\\_2255.html](https://aes.basu.ac.ir/article_2255.html) (In Persian).
- Komijani, A. & Alinejad-Mehrabani, F. (2012). "Evaluating the Effectiveness of Monetary Transmission Channels on Production and Inflation besides Analyzing their Relative Importance in Iran's Economy". *Journal of Planning and Budgeting*. 17(2): 39-63. <https://eprj.ir/article-1-609-fa.html> (In Persian).
- Le, V. P. M., Matthews, K., Meenagh, D., Minford, P. & Xiao, Z., (2022). "Regulatory arbitrage, shadow banking and monetary policy in China". *Journal of International Financial Markets, Institutions and Money*, 80: 101640. <https://doi.org/10.1016/j.intfin.2022.101640>
- Li, H., Ni, J., Xu, Y. & Zhan, M., (2021). "Monetary policy and its transmission channels: Evidence from China". *Pacific-Basin Finance Journal*, 68: 101621. <https://doi.org/10.1016/j.pacfin.2021.101621>
- Makipour, A., Salahmanesh, A. & Anvari, E., (2023). "Analysis the effects of monetary policy in Iran's economy with the existence of shadow banking, using dynamic stochastic general equilibrium method". *Stable Economy Journal*, 4(2): 174-206. <https://doi.org/10.22111/sedj.2023.45577.1341> (In Persian).
- Mazelis, F., (2015). "The role of shadow banking in the monetary transmission mechanism and the business cycle". (No. 2015-040). SFB 649 Discussion Paper.
- Mirjalili, S. H., (2015). *Schools of economic thought*. Institute for Humanities and Cultural Studies. Press Tehran: 433-465 (In Persian).
- Mirjalili, S. H., (2017). "Conventional vs. unconventional monetary policy: A comparative study". *Journal of Iranian Economic Issues*, 3(2): 111-125. [https://economics.ihs.ac.ir/article\\_2679.html?lang=fa](https://economics.ihs.ac.ir/article_2679.html?lang=fa) (In Persian).
- Mishkin, F. S., (1995). "Symposium on the monetary transmission mechanism". *Journal of Economic perspectives*, 9(4): 3-10. <https://doi.org/10.1257/jep.9.4.3>

- Mishkin, F. S., (1996). "The channels of monetary transmission: Lessons for monetary policy". *National Bureau of Economic Research*. Working paper 5464. <https://doi.org/10.3386/w5464>
- Mishkin, F. S., (2019). *The economics of money, banking, and financial markets*. Twelfth Edition. Pearson education.
- Raei, R., Iravani, M. J. & ahmadi, T., (2018). "Monetary Shocks and Monetary Transmission Mechanism in The Iranian Economy: With Emphasis on Exchange Rates, Housing Prices and Credits". *Economic Growth and Development Research*, 8(31): 29-44. [https://egdr.journals.pnu.ac.ir/article\\_4342.html?lang=fa](https://egdr.journals.pnu.ac.ir/article_4342.html?lang=fa) (In Persian).
- Schairer, S., (2024). "The contradictions of unconventional monetary policy as a post-2008 thwarting mechanism: financial dominance, shadow banking, and inequality". *Review of Evolutionary Political Economy*, 5(1): 1-29. <https://doi.org/10.1007/s43253-024-00115-3>
- Walsh, C.E., (2017). *Monetary Theory and Policy*. MIT Press Books, Fourth Edition. ISBN 9780262035811.
- Yang, L., van Wijnbergen, S., Qi, X. & Yi, Y., (2019). "Chinese shadow banking, financial regulation and effectiveness of monetary policy". *Pacific-Basin Finance Journal*, 57: 101169. <https://doi.org/10.1016/j.pacfin.2019.06.016>
- Zhang, H., Skolnik, R., Han, Y. & Wu, J., (2020). "The Impacts of China's Shadow Banking Credit Creation on the Effectiveness of Monetary Policy". *International Journal of Finance & Banking Studies*, 9(4): 33-46. <https://doi.org/10.20525/ijfbs.v9i4.899>
- Zarei, M., Esfandiary, M. & Mirjalili, S. H., (2021a). "The Impact of Shadow Banking on the Effectiveness of Monetary Policy: Evidence from G20 Countries". *Journal of Monetary & Banking Research*, 13(46): 237-252. <https://doi.org/10.52547/jme.16.2.237> (In Persian).
- Zarei, M., Esfandiary, M. & Mirjalili, S. H., (2021b). "The Impact of Shadow Banking on the Financial Stability: Evidence from G20 Countries". *Journal of Money and Economy*, 16(2): 237-252. <https://doi.org/10.52547/jme.16.2.237>



**فصلنامه علمی مطالعات اقتصادی کاربردی ایران**  
 شاپای چاپی: ۲۵۲۰-۲۳۲۲؛ شاپای الکترونیکی: ۴۷۲۲-۲۳۲۲ - وبسایت نشریه: <https://aes.basu.ac.ir>  
 نشریه گروه اقتصاد، دانشکده علوم اقتصادی و علوم اجتماعی، دانشگاه بوعلی سینا، همدان، ایران.  
 حق انتشار این مستند، متعلق به نویسنده(گان) آن است. ۱۴۰۴ - ناشر این مقاله، دانشگاه بوعلی سینا است.  
 این مقاله تحت گواهی زیر منتشر شده و هر نوع استفاده غیرتجاری از آن مشروط بر استناد صحیح به مقاله و با رعایت شرایط مندرج در آدرس زیر مجاز است.  
 آدرس زیر مجاز است.  
 Creative Commons Attribution-NonCommercial 4.0 International license (<https://creativecommons.org/licenses/by-nc/4.0/>)



## بررسی تأثیر بانکداری سایه بر انتقال سیاست پولی در ایران با استفاده از رویکرد DSGE

مهران زارعی<sup>۱</sup> ID، مرضیه اسفندیاری<sup>۲</sup> ID، سید حسین میرجلیلی<sup>۳</sup> ID

نوع مقاله: پژوهشی

شناسه دیجیتال: <https://doi.org/10.22084/aes.2025.30883.3788>

تاریخ دریافت: ۱۴۰۴/۰۲/۰۹، تاریخ بازنگری: ۱۴۰۴/۰۴/۰۹، تاریخ پذیرش: ۱۴۰۴/۰۴/۲۰  
 صص: ۴۱-۹

### چکیده

شناخت دقیق مکانیزم‌های انتقال سیاست پولی و عوامل مؤثر بر آن، به منظور اجرای موفق یک سیاست پولی امری ضروری است. فعالیت بانکداری سایه به دلیل تداخل در نقش وام‌دهی بانک‌ها، می‌تواند کانال اعتباری انتقال سیاست پولی را تضعیف کند. بر این اساس و با توجه به افزایش فعالیت بانکداری سایه در نظام مالی ایران طی سال‌های اخیر، پرسش اصلی این است که بانکداری سایه چه تأثیری بر انتقال (اثربخشی) سیاست پولی در ایران دارد؟ هدف پژوهش حاضر بررسی تأثیر بانکداری سایه بر انتقال سیاست پولی در ایران است. برای این منظور از مدل تعادل عمومی پویای تصادفی استفاده شده است که در آن، دو سناریوی اقتصاد بدون بانکداری سایه و اقتصاد با بانکداری سایه در نظر گرفته شده است. در هر سناریو، تأثیر شوک دو سیاست پولی تغییر نرخ رشد عرضه پول و تغییر نرخ سود (بهره) بر متغیرهای تولید، سرمایه‌گذاری و تورم بررسی شده است. نتایج این پژوهش نشان می‌دهد که وجود بانکداری سایه در اقتصاد، باعث تضعیف کانال اعتباری انتقال سیاست پولی شده و تأثیر سیاست پولی بر هر سه متغیر را کاهش می‌دهد. این یافته‌ها نشان می‌دهد هنگامی که بانکداری سایه وارد مدل می‌شود، به دلیل این‌که بانک‌های سایه تابع مقررات سخت‌گیرانه بانک مرکزی نیستند، کاهش وام‌دهی بانک‌های تجاری (سنتی) در نتیجه اعمال سیاست پولی انقباضی را تا حدی جبران می‌کنند. این موضوع باعث می‌شود سرمایه‌گذاری در واکنش به شوک منفی نرخ رشد پول افزایش یابد. با اعمال شوک مثبت نرخ بهره نیز واکنش متغیرهای تولید و سرمایه‌گذاری در سناریوی با بانکداری سایه نسبت به سناریوی بدون بانکداری سایه معکوس می‌گردد.

**کلیدواژگان:** بانکداری سایه، انتقال سیاست پولی، مدل DSGE، اقتصاد ایران.

**طبقه‌بندی JEL:** E42, E44, E51, E52, G20.

۱. دانشجوی دکتری اقتصاد، گروه اقتصاد، دانشکده اقتصاد و علوم اداری، دانشگاه سیستان و بلوچستان، زاهدان، ایران.

Email: [mehr.zareil14@gmail.com](mailto:mehr.zareil14@gmail.com)

۲. دانشیار گروه اقتصاد، دانشکده اقتصاد و علوم اداری، دانشگاه سیستان و بلوچستان، زاهدان، ایران (نویسنده مسئول).

Email: [m.esfandiari@eco.usb.ac.ir](mailto:m.esfandiari@eco.usb.ac.ir)

۳. استاد گروه اقتصاد، پژوهشکده اقتصاد، پژوهشگاه علوم انسانی و مطالعات فرهنگی، تهران، ایران.

Email: [h.jalili@ihcs.ac.ir](mailto:h.jalili@ihcs.ac.ir)



**Applied Economics Studies, Iran (AESI)**P. ISSN:2322-2530 & E. ISSN: 2322-472X - Journal Homepage: <https://aes.basu.ac.ir/>Scientific Journal of Department of Economics, Faculty of Economic and Social Sciences,  
Bu-Ali Sina University, Hamadan, Iran. Owner & Publisher: Bu-Ali Sina University.

© Copyright © 2025 The Authors. Published by Bu-Ali Sina University.

This work is licensed under a Creative Commons Attribution-NonCommercial  
4.0 International license (<https://creativecommons.org/licenses/by-nc/4.0/>). Non-commercial uses  
of the work are permitted, provided the original work is properly cited.

## Financialization and Welfare in Iran: The Institutional Quality Paradox

Reza Maaboudi<sup>1</sup> , Ramin Khochiany<sup>2</sup> , Younes Nademi<sup>3</sup> 

Type of Article: Research

 <https://doi.org/10.22084/aes.2025.31450.3820>

Received: 2025/08/20; Revised: 2025/09/13; Accepted: 2025/09/17

Pp: 43-65

### Abstract

Understanding the impact of financialization on the economy is crucial for policymakers seeking to design strategies that enhance social welfare. This study examines the effect of financialization on economic welfare in Iran from 1990 to 2023, employing a threshold regression approach to account for nonlinear dynamics. The results reveal a threshold level of institutional quality at 57%. Across both, i.e., low and high institutional quality regimes, financialization exerts a negative and significant influence on economic welfare. However, once institutional quality surpasses the threshold, the adverse impact of financialization intensifies markedly. Findings highlight the paradoxical role of institutional quality, showing that greater financialization consistently undermines welfare in Iran, with stronger institutions amplifying rather than mitigating its negative effects. It means that in environments with higher institutional quality, advanced financial instruments and capital markets develop; however, access to financial development is usually asymmetrical. Consequently, wealthy individuals and large corporations benefit the most, while low-income households receive minimal benefits and may even suffer from asset inflation or consumer debt. Thus, strong institutions do not necessarily prioritize public welfare. Policymakers may regulate to develop financial markets in a way that prioritizes the financial sector's profitability over social interests. This mechanism can lead to financial sector growth occurring faster than the real economy's capacity, ultimately undermining welfare.

**Keywords:** Financialization, Economic Welfare, Institutional Quality, Threshold Regression, Approach, Iran.

**JEL Classification:** I31, G10, O16, E44.

1. Associate Professor, Department of Economics, Faculty of Humanities, Ayatollah Boroujerdi University, Boroujerd, Iran (Corresponding Author). **Email:** [maaboudi@abru.ac.ir](mailto:maaboudi@abru.ac.ir)

2. Associate Professor, Department of Economics, Faculty of Humanities, Ayatollah Boroujerdi University, Boroujerd, Iran.

3. Associate Professor, Department of Economics, Faculty of Humanities, Ayatollah Boroujerdi University, Boroujerd, Iran.

**Citations:** Maaboudi, R., Khochiany, R. & Nademi, Y., (2025). "Financialization and Welfare in Iran: The Institutional Quality Paradox". *Journal of Applied Economics Studies in Iran*, 14(55): 43-65. <https://doi.org/10.22084/aes.2025.31450.3820>

**Homepage of this Article:** [https://aes.basu.ac.ir/article\\_6259.html?lang=en](https://aes.basu.ac.ir/article_6259.html?lang=en)

## 1. Introduction

Financial development enhances economic performance by improving risk management, facilitating resource access, reducing financing costs, and directing funds toward profitable and productive activities. Financial development plays a substantial role in raising productivity and promoting economic growth by providing the necessary tools and institutions for mobilizing and allocating savings to productive investments. However, in recent decades, most developing and developed countries have experienced profound transformations in their financial sectors, including extensive deregulation of financial markets, capital account liberalization, and the privatization of banking systems. As a result, economies have experienced the rapid expansion of the financial sector, the increasing reliance of non-financial corporations on financial activities, and the participation of households in financial markets with the aim of generating returns. This process is commonly called the *financialization of the economy* (Sawyer, 2024). The concept highlights the growing influence of financial markets, institutions, and practices on the overall functioning of the economy—often at the expense of the real sector (Saha *et al.*, 2025).

In this process, the pursuit of profit through financial channels—such as asset trading, borrowing, speculative investment, and complex financial instruments—tends to replace value creation through real production. Although such structural changes may facilitate access to credit and investment opportunities, they also generate complex and multidimensional effects on economic variables. As financialization progresses, financial profits increasingly gain importance relative to traditional modes of production and may even supplant them altogether. Beyond altering production structures, financialization reshapes individual and collective perceptions of markets. These changes bring about unintended consequences, impacting economic growth and even the redistribution of power. The financialization process means that household spending decisions are influenced not only by labor income and the wealth effect, but also by the volatility of financial assets. As a result, by shaping the expenditure decisions of major economic actors, financialization has a significant impact on economic policies, business cycles, and the genesis of crises (Braga *et al.*, 2017). From a more recent perspective, financialization is not merely an economic phenomenon but also an institutional and political transformation, in which financial institutions gain significant influence over public policies, inequality, and social welfare. Particularly in developing countries, the rapid expansion of the financial sector without effective regulatory oversight can lead to economic fragility, increased household vulnerability, and reduced sustainability of growth (Akan & Gunduz, 2025).

Over the past two decades in Iran, the financial sector has grown and expanded significantly relative to the real sector. Amid prolonged stagflation and declining real incomes, households and firms operating in the real economy have increasingly sought opportunities in financial markets. Given Iran's considerable dependence on oil revenues, alongside the relatively nascent and evolving structure of its financial institutions, financialization may have distinctive and multifaceted effects on key macroeconomic variables. Empirical evidence suggests that financialization in Iran influences saving, inflation, income distribution, and economic growth through various channels—including shifts in labor market structures, the rising importance of capital markets over traditional banking, the introduction of complex financial instruments, and the transition of firms from productive to financial activities ([Maaboudi & Dare Nazari, 2021](#)). Since social welfare is a function of both aggregate income and its distribution ([Stark, 2025](#)), financialization affects welfare through its impacts on income distribution ([Zhang & Wang, 2025](#)) and economic growth ([Doruk, 2024](#)). Yet, its overall effect on welfare remains ambiguous. On the one hand, financialization may enhance welfare by deepening financial markets, creating new investment opportunities, improving liquidity, and facilitating access to credit. On the other hand, it can undermine welfare by generating financial instability, widening income inequality, reducing productive investment, and imposing greater risks on households.

The imperative for this research is particularly acute given Iran's current economic conditions. The country confronts severe challenges, including inflation, income inequality, and diminishing social welfare, while its financial system is simultaneously undergoing a transition from a traditional bank-centric model towards a more market-oriented and complex structure. Within this environment, a nuanced understanding of financialization's effects on welfare is crucial for informing sound policy and strategic economic planning. Although the topic is of increasing international importance, a significant gap persists in the domestic literature. The relationship between financialization and economic welfare has not been studied within the country, while international studies have predominantly used income distribution as a proxy for welfare. Consequently, the current research intends to bridge this gap by exploring the nonlinear relationship between financialization and economic welfare, focusing on the intermediary role of institutional quality. Examining the role of institutional quality on the effects of financialization on welfare is important because it reveals whether institutional quality, as a mediating variable, can amplify or mitigate these effects.

## 2. Literature Review

Kevin Phillips (1993) was among the first to define *financialization* as the systematic separation of the financial sector from the real economy. In his view, financialization represents a process through which the rapid and disproportionate expansion of finance ultimately dominates the real economy, intensifies financial wealth effects, and makes financial profit a general objective. Initially, financialization provided firms with capital to expand production, share surplus value, and accumulate rents before exiting the cycle. Over time, however, the financial cycle increasingly replaced the production cycle as the main avenue of capital accumulation. With the persistence and excess of financialization, this process strengthened the dominance of financial circuits over markets, crowding out productive investment, reducing employment growth, real wages, and consumption, while amplifying the profitability of financial incomes and pushing industrial capital toward speculative and virtual accumulation (Chen & Jiao, 2025). Thus, in financialization, markets, institutions, and financial activities assume a growing role in the economy, with financial logic replacing the logic of production and income distribution (Epstein, 2005). By encouraging speculative activities and complex financial instruments, financialization increases systemic risk and financial instability. These instabilities—manifested in financial crises, market collapses, and asset devaluations—have severe welfare consequences, especially for vulnerable groups. As Krippner (2005) notes, financialization does not generate sustainable economic growth but rather fosters volatile cycles that erode welfare outcomes. Overall, the rise of financialization weakens non-financial corporations, constrains aggregate demand, and limits governments' ability to use policy tools to promote full employment, welfare, and development (Izurieta *et al.*, 2018).

In recent years, greater attention has been paid to how financialization penetrates firms' and households' decision-making, reflecting the growing influence of financial motives, markets, institutions, and elites over economic policy, corporate behavior, and household consumption. This shift is associated with the increasing dominance of finance over the real economy, signifying a transition from industry- and production-based growth toward an economy increasingly dependent on financial transactions, speculation, and shareholder value maximization (Malika *et al.*, 2025).

### 2-1. Channels of Financialization's Impact on Economic Welfare

Financialization, as a defining trend of modern economies, has far-reaching implications for macroeconomic variables and social structures. Much of the research has focused on its effects on economic growth and income inequality (Akan & Gündüz, 2025). However,

closer examination shows that financialization also influences welfare through multiple channels—both directly via financial markets and indirectly through changes in state and household behavior.

## 2-2. Economic Growth

The first major channel is *investment*. As profitability in the financial sector rises, firms reallocate resources from productive investment to financial activities, reducing capital accumulation and long-term growth. Institutional investors' pressure for short-term returns further discourages long-term investment and R&D ([Barradas, 2017](#)). Accordingly, reducing financialization may encourage firms to redirect financial resources toward the real economy, thereby boosting growth. Gutierrez and Philippon (2017) highlight concerns in both developed and developing countries over the negative effects of financialization on investment, economic growth, and financial stability. Conversely, [Mabebe \(2024\)](#), in a cross-country study covering 1996–2022, finds that financialization had a significantly positive impact on growth in developing economies with large financial sectors. Another channel is the expansion of finance's demand for skilled labor. As talented workers are drawn into finance, the real sector faces a human capital shortage, thereby depressing output ([Li, 2021](#)). [Doruk \(2024\)](#), studying emerging Asian economies, shows that financialization diverts resources toward speculative activities, weakening investment in human capital and, ultimately, undermining growth.

## 2-3. Income Distribution

The first mechanism linking financialization to income inequality is the growing size and power of the financial sector, especially under post-Keynesian frameworks emphasizing financial market behavior. Globalization of finance, deregulation, securitization, and the rise of capital markets collectively weaken redistributive policies and intensify inequality ([Vita & Liu, 2021](#)). A second mechanism is regulatory change. Policies encouraging profit maximization and speculative opportunities motivate non-financial firms to shift resources from productive to financial investments ([Lin & Tomaskovic-Devey, 2013](#)), thereby depressing wages and employment in the real economy. A third channel is the financial dependence of non-financial corporations. Financial markets compel firms to adopt shareholder value strategies, shifting financial repayment pressures onto workers through wage suppression and cost-cutting, which enhances managerial rewards while deepening inequality ([van der Zwan, 2014](#)). Cross-country evidence confirms this: [Lee & Siddique \(2021\)](#) find that between 1998 and 2017, financialization exacerbated inequality across

emerging, developing, and advanced economies alike. Similarly, [Bhaduri & Oro \(2025\)](#) show that asset prices and asymmetric access to credit widen inequality, weakening welfare transmission from growth. [Chen & Jiao \(2025\)](#) further note that financialization intensifies urban–rural wage gaps while marginally reducing asset-income inequality, with strong spatial spillover effects consistent with the *club convergence* phenomenon. Policies such as financial regulation, inclusive financial systems, and balanced regional development could mitigate these disparities.

#### 2-4. Household Debt and Financial Fragility

Another major welfare channel is rising household indebtedness. Financialization expands access to consumer credit, allowing households to spend beyond their current income. While this may raise perceived welfare in the short term, it produces long-term vulnerability, weaker real purchasing power, and psychological stress from debt ([Montgomerie & Büdenbender, 2015](#)). Moreover, mortgage-based policies of *asset-based welfare* have tied household wellbeing to volatile housing markets, with devastating effects during crises such as the 2008 financial meltdown.

#### 2-5. Job Insecurity and Declining Employment Quality

Financialization alters corporate priorities, shifting from long-term investment toward short-term profit maximization for shareholders. This reduces investment in human capital, promotes temporary and informal contracts, and erodes workers' bargaining power. The result is greater job insecurity, lower real wages, and a deteriorating quality of life. In economies lacking strong social protection systems, these trends directly undermine household welfare ([Doruk, 2024](#)).

#### 2-6. Weakening of the Government's Role and Redistributive Policies

A critical indirect effect of financialization lies in its transformation of state policy. As finance gains influence, governments increasingly design policies favoring investors rather than the broader public. This erodes redistributive and welfare policies, diminishes social capital, and weakens governments' responsiveness to social crises ([Epstein, 2005](#)). By prioritizing financial stability over social welfare, states redirect resources away from productive sectors such as education, healthcare, and infrastructure. Financialization also commercializes public services, thereby limiting equitable access to welfare ([Gabor, 2019](#)). In this sense, financialization systematically increases inequality and reduces the economy's capacity to support collective welfare ([Akan & Gündüz, 2025](#)). [Saha et al.,](#)

(2025) further argue that while financialization often reduces welfare by exacerbating inequality, democratic governance and strong institutions can mitigate these effects. Absent effective institutions, however, financialization tends to concentrate income and widen inequality.

## 2-7. Institutional Quality

The role of institutional quality in shaping financialization's welfare effects is crucial. Poor institutional quality is a major reason why resource-rich economies often experience weak growth. Evidence suggests that while in high-quality institutional settings, financialization may foster sustainable growth and more equitable income distribution, in countries like Iran with institutional weaknesses, it often exacerbates inequality and undermines welfare (Akan & Gündüz, 2025). Thus, institutional quality serves as a critical channel moderating financialization's welfare impact.

In sum, the literature shows that no study has yet directly examined the effect of financialization on welfare using a comprehensive welfare index. Most previous research relied on income inequality indicators as proxies for welfare. This study addresses this gap by employing the composite index of welfare proposed by Osberg and Sharpe (2002), which includes not only growth and inequality but also broader welfare dimensions. Furthermore, unlike prior studies, this research investigates the *threshold effects* of financialization on welfare, thereby offering a novel contribution to the literature.

## 3. Methodology

### 3-1. Model Specification and Data Description

The main purpose of the current study is to investigate the financialization impact on economic welfare in Iran. Following the literature, the relationship is specified as:

$$W_t = f(\ln y_t, q_t, fin_t, E_t) \quad (1)$$

where  $W_t$  represents the composite index of economic welfare,  $\ln y_t$  is the logarithm of real GDP,  $q_t$  denotes the size of government,  $fin_t$  captures financialization, and  $E_t$  is a vector of control variables affecting welfare, including the misery index, income distribution, human capital, international sanctions, trade openness, and sanctions. Economic and social welfare refers to a situation in which individuals and households not only have adequate economic resources to meet basic needs such as food, housing, education, and healthcare, but also live in an environment that ensures economic security, equal opportunities, social stability, and the possibility of active participation in economic and political processes. This concept goes beyond per capita income and encompasses

quality of life, distributive justice, economic sustainability, and social protection (Stiglitz *et al.*, 2009). Accordingly, following Osberg and Sharpe (2002), a composite index comprising four components- consumption flows (CF), wealth accumulation (WS), income distribution (ID), and economic security (ES)-is used to measure the Index of Economic Well-Being (IEWB), as defined by Equation (2).

$$IEWB = \underbrace{\beta_1[(C + G + WT - RE)](LE)}_{CF} + \underbrace{\beta_2[(K + RD + HC + NR + FD - ED)]}_{WS} + \underbrace{\beta_3[(\gamma(PHR) + (1 - \gamma)Gini)]}_{ID} + \underbrace{\beta_4[WWR + \delta(ILL) + \theta(SSP) + \omega(OLD)]}_{ES}$$

(2)

where  $C$  is real per capita household consumption expenditure,  $G$  is real per capita government consumption expenditure,  $WT$  represents real per capita value of changes in working time,  $RE$  is real per capita value of compensatory expenditures,  $LE$  denotes life expectancy at birth indexed to the base year 1979,  $K$  is the real per capita gross fixed capital stock,  $RD$  represents the real per capita stock of research and development expenditure,  $HC$  is the real per capita human capital stock,  $NR$  denotes the real per capita stock of natural resource wealth,  $FD$  is real per capita net foreign direct investment inflows,  $ED$  is the Real per capita social cost of environmental degradation (pollution from  $CO_2$  emissions),  $gini$  is the Gini coefficient,  $PHR$  is poverty headcount ratio at the household level at a minimum income of \$1.25 per day; however, due to the unavailability of data for this measure, the income ratio of the top 10% to the bottom 10% is used as a proxy,  $\gamma$  is relative weight of poverty that set to 0.75,  $WWR$  is working-age population (15-65 years) to total population ratio,  $\delta$  is the share of the population at risk of disease (assumed to be 100%),  $ILL$  is the ratio of out-of-pocket health expenditures to disposable income,  $SSP$  is the risk associated with single parenthood,  $\theta$  is the proportion of women with children,  $OLD$  is the risk of exposure to poverty, and  $\omega$  is the share of population between aged 45 to 66 years. Also,  $\beta_1$  is the consumption flow coefficient,  $\beta_2$  is the wealth accumulation coefficient,  $\beta_3$  is the income distribution coefficient, and  $\beta_4$  is the economic security coefficient. To measure financialization, following the study by Zheng *et al.*, (2025), the ratio of the value added of the financial, insurance, and real estate sectors to GDP is utilized. To quantify the institutional quality, a composite index of good governance components is used, in which the data are normalized to a range between 0 and 2.5. Given the imposition of extensive sanctions on the Iranian economy, a dummy variable is employed to capture the effects of sanctions on economic welfare. This variable takes the value of one for the years during which sanctions were in effect and zero otherwise. The data frequency is annual, covering the period from 1990 to 2023. Furthermore, all nominal variables are converted to real

terms using the Consumer Price Index (CPI) with the base year 2016, as calculated and published by the Central Bank of Iran. To estimate the financialization effects on welfare and analyze relationships among variables, the threshold regression approach is employed. Following Hansen (2000), a two-regime threshold model is specified:

$$y_t = \alpha_1' x_t + \varepsilon_{1t}, \quad q_t < z \quad (3)$$

$$y_t = \alpha_2' x_t + \varepsilon_{2t}, \quad q_t \geq z \quad (4)$$

where  $y_t$  is the dependent variable (welfare),  $x_t$  is the explanatory variable,  $\alpha_i'$  is the explanatory variable's coefficients,  $\varepsilon_{it}$  is the error term,  $q_t$  is the threshold variable (institutional quality), and  $z$  is the threshold value of institutional quality. Based on the equations above, Equation (3) is estimated for values of the threshold variable below the threshold, and Equation (4) for values above it. To introduce single-equation regression using equations (3) and (4) and the dummy variable, we have:

$$y_t = \alpha' x_t + \rho' x_t(z) + \varepsilon_t, \quad \varepsilon_t \sim iid(0, \sigma_t^2), \quad x_t(z) = \begin{cases} x_t I(q_t < z) \\ x_t I(q_t \geq z) \end{cases} \quad (5)$$

In equation (5), the parameters are defined as follows:  $\alpha = \alpha_2$ ,  $\rho = \alpha_1 - \alpha_2$  and  $\varepsilon_t = [\varepsilon_{1t} \ \varepsilon_{2t}]'$ . The dummy variable  $I_t(Z)$  is defined as  $I_t(Z) = \{q_t < z\}$ . If  $q_t < z$ , the dummy variable is assigned the number one, and otherwise it is assigned the number zero. In the threshold regression approach, the threshold value of institutional quality is calculated by minimizing the sum of squared errors. By estimating the parameters, the sum of squared errors  $SS_t(z) = (\widehat{\varepsilon_t(z)})'(\widehat{\varepsilon_t(z)})$ , the optimal threshold value  $\hat{z} = \argmin SS_t(z)$  and the residual variance of the model  $\hat{\sigma}^2 = \frac{1}{T} SS_t(\hat{z})$  are extracted. By calculating  $\hat{z}$ , the coefficients  $\hat{\theta} = \hat{\theta}(\hat{z})$  and  $\hat{\alpha} = \hat{\alpha}(\hat{z})$  are estimated. Finally, considering the research objectives, the specification of the research model is introduced based on equation (6):

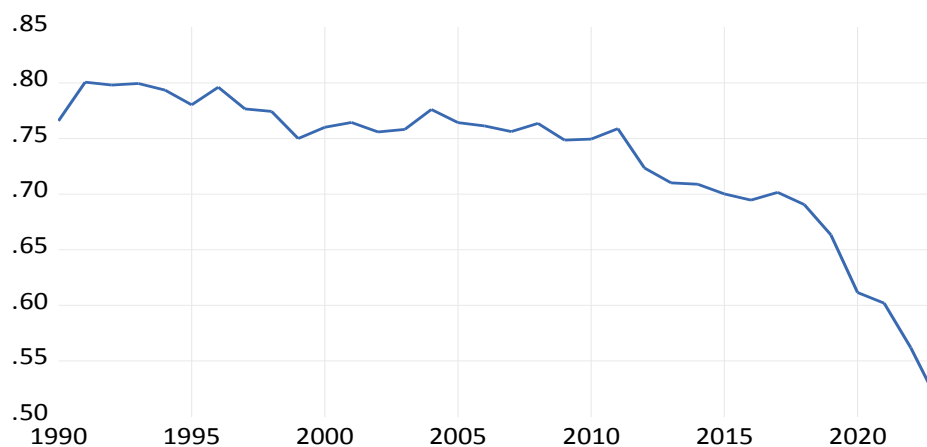
$$W_t = \alpha_0 + \alpha_i'^{x_t} I(q_t < z) + \alpha_j'^{x_t} I(q_t \geq z) + \gamma_1 Tr_t + \gamma_2 M_t + \gamma_3 Gi_t + \gamma_4 H_t + \gamma_5 D_t + \varepsilon_t \quad (6)$$

where  $x_t$  represents the vector of explanatory variables in the regime, namely financialization, institutional quality, and the logarithm of GDP,  $\alpha'^{x_t}$  denotes their coefficients,  $q_t$  is the threshold variable (institutional quality),  $z$  is the threshold value of institutional quality. The non-threshold control variables are defined as the trade openness,  $M_t$  misery index,  $Gi_t$  Gini coefficient,  $H_t$  human capital,  $D_t$  sanctions. Also,  $\gamma$  is the coefficient vector of the non-threshold variables, and  $\varepsilon_t$  is the disturbance component and is assumed to follow the white noise process. To test the significance of the existence of a threshold according to the Lagrange-Hansen coefficient, the  $F$  statistic is used as  $F =$

$\frac{SS_t - SS_t(\hat{z})}{\hat{\sigma}^2}$ , where  $SS_t$  represents the sum of squared errors in the regression without threshold and  $SS_t(\hat{z})$  represents the sum of squared errors in the case of the threshold. The null hypothesis in the above test is stated as  $H_0: \alpha_1 = \alpha_2$  and states that the regression pattern is linear.

#### 4. Findings

To calculate the composite economic welfare index, different coefficients are assigned to each of the components of consumption flow, wealth accumulation, income distribution, and economic security, depending on their importance. In the present study, following the research of [Osberg & Sharpe \(2002\)](#), the coefficients of consumption flow, wealth accumulation, income distribution, and economic security are considered to be 0.4, 0.1, 0.25, and 0.25, respectively. Figure 1 reports the trend of changes in Iran's composite economic welfare index during the period of 2020 to 2023. As can be seen, welfare has a downward trend during the period. However, from 1990 to 2011, welfare experienced a higher level than from 2012 to 2023.



**Fig. 1: Composite Index of Economic Well-being in the Country from 1990 to 2023 (Research Calculations).**

From 1990 to 2011, economic welfare reached a higher average level due to factors such as increased economic growth, reduced income inequality, granting facilities to combat unemployment, and a subsequent decline in unemployment rates. In contrast, during the period of 2012-2023, the imposition of new economic sanctions, increased inflation, increased exchange rates, and gold prices caused income inequality to increase and economic growth to decrease, resulting in a lower level of economic welfare. Table 1

provides a summary of the descriptive statistics, measurement method of variables, and data sources. Nominal variables were deflated using the Consumer Price Index (2016=100).

**Table 1: Descriptive statistics of variables**

| Variable Name                | Measurement Method                                                                                                           | Data Source | Mean   | Std. Dev. |
|------------------------------|------------------------------------------------------------------------------------------------------------------------------|-------------|--------|-----------|
| <b>Economic Welfare</b>      | Composite index including four components: consumption flow, wealth accumulation, income distribution, and economic security | CBI & WDI   | 0.74   | 0.061     |
| <b>Financialization</b>      | Ratio of value added in the finance, insurance, and real estate sector to GDP                                                | CBI         | 0.1783 | 0.0384    |
| <b>Log of Real GDP</b>       | Logarithm of real GDP                                                                                                        | CBI         | 6.128  | 0.89      |
| <b>Institutional Quality</b> | Average of good governance components                                                                                        | WDI         | 1.459  | 0.784     |
| <b>Misery Index</b>          | The sum of the inflation rate and the unemployment rate                                                                      | WDI & IMF   | 0.346  | 0.112     |
| <b>Gini Coefficient</b>      | The difference in income distribution among individuals in the country                                                       | SCI & WDI   | 0.3981 | 0.009     |
| <b>Trade Openness</b>        | The ratio of the sum of exports and imports to GDP                                                                           | CBI         | 0.4403 | 0.067     |
| <b>Human Capital</b>         | Ratio of university students to total population                                                                             | CBI         | 0.195  | 0.032     |

(Research Calculations).

The low standard deviation of the variables indicates that the data has little dispersion.

To avoid spurious regression, the stationarity of the data is first tested. For this purpose, the Zivot & Andrews test is used. Since the variables are at the level of nonstationary, the first-order difference of the variables is first calculated and retested. Table 2 reports the results of the Zivot & Andrews stationarity test in three cases: time changes and stationarity in the level, time changes and stationarity in the slope of the trend function, and time changes and stationarity in the level and slope of the trend function for the first-order difference of the variables.

**Table 2: Unit Root Test Results**

| Variable Name | Time trend and stationarity in level |                |       | Time trend and stationarity in trend slope |                |       | Time trend and stationarity in level and trend slope |                |       |
|---------------|--------------------------------------|----------------|-------|--------------------------------------------|----------------|-------|------------------------------------------------------|----------------|-------|
|               | Test Statistic                       | Critical Value | Break | Test Statistic                             | Critical Value | Break | Test Statistic                                       | Critical Value | Break |
| $W_t$         | -7.61*                               | -5.34          | 2018  | -7.33*                                     | -5.06          | 2018  | -5.39                                                | -5.17          | 2013  |
| $Fin_t$       | -5.97                                | -5.34          | 2020  | -5.58                                      | -5.06          | 2021  | -5.86*                                               | -5.72          | 2014  |
| $logY_t$      | -4.96                                | -4.85          | 2004  | -6.27*                                     | -5.06          | 2006  | -8.92*                                               | -5.17          | 2004  |
| $Z_t$         | -6.27*                               | -5.34          | 2017  | -4.71                                      | -4.52          | 2010  | -5.78*                                               | -5.72          | 2017  |
| $Tr_t$        | -5.41                                | -5.34          | 2020  | -5.26                                      | -5.06          | 2021  | -5.74                                                | -5.72          | 2018  |
| $GI_t$        | -7.905*                              | -5.34          | 2009  | -7.81*                                     | -5.06          | 2003  | -8.77*                                               | -5.72          | 2011  |

|       |        |       |      |        |       |      |        |       |      |
|-------|--------|-------|------|--------|-------|------|--------|-------|------|
| $H_t$ | -7.34* | -5.34 | 2019 | -6.81* | -5.06 | 2014 | -7.17* | -5.72 | 2016 |
| $M_t$ | -5.86* | -5.34 | 1995 | -5.30* | -5.06 | 1997 | -5.73* | -5.72 | 1995 |

(Researcher's findings). \*Significant at the one percent level

The structural unit root test results indicate that the first-order difference of the variables is stationary at the 5% error level. Therefore, before estimating the main research model, cointegration and the existence of a long-run relationship among the variables are tested. Considering the nonlinear approach in the regression and the degree of first-order integration of the model variables, the Enders and Siklos threshold cointegration approach is used to examine the long-run equilibrium relationship between the research variables (Enders & Siklos, 2001). For this purpose, based on equation (7), the null hypothesis  $\rho_1=\rho_2$  is tested, meaning the absence of threshold cointegration.

$$\Delta \xi_t = I_t \rho_1 \xi_{t-1} + (1 - I_t) \rho_2 \xi_{t-1} + \gamma_1 \Delta \xi_{t-1} + \dots + \gamma_p \Delta \xi_{t-p} + \pi_t \quad (7)$$

Where,  $\xi_t$  is the disturbance component extracted from regressing public debt on explanatory variables; also, the  $I_t$  function is defined as  $I_t = \begin{cases} 1, & \text{if } \xi_{t-1} \geq \tau \\ 0, & \text{if } \xi_{t-1} < \tau \end{cases}$  with respect to the threshold level  $\tau$ . For testing nonlinear cointegration among the study variables, the optimal lag order of the model was selected as 2 based on the Schwarz Bayesian Criterion (SBC). Table 3 reports the results of the threshold cointegration test. The critical values and simulation statistics of the F test, T-max, and  $\Phi$  were extracted based on 15,000 Monte Carlo simulations and at a 5 percent error level.

**Table 3. Threshold Cointegration Test Results**

| Variable                                                  | Coefficient    | t-Student      |
|-----------------------------------------------------------|----------------|----------------|
| $I_t \xi_{t-1}$                                           | -2.022         | -4.501         |
| $(1 - I_t) \xi_{t-1}$                                     | -1.63          | -4.105         |
| $\Delta \xi_{t-1}$                                        | 0.568          | 1.86           |
| $\Delta \xi_{t-2}$                                        | 0.346          | 1.197          |
| <b>Simulated Critical Values at 5% Significance Level</b> |                |                |
| Test                                                      | Test Statistic | Critical Value |
| <b>F: <math>\rho_1=\rho_2</math></b>                      | 8.98           | 5.863          |
| <b>T-max</b>                                              | -3.218         | -2.875         |
| <b><math>\Phi</math>: <math>\rho_1=\rho_2=0</math></b>    | 11.792         | 10.851         |

(Researcher's calculations).

The results show that the adjustment coefficient in the first regime is -2.022 and in the second regime is -1.63, which indicates the asymmetry of cointegration between the variables in the two regimes; so that the adjustment speed in the second regime is lower than in the first regime. Based on the F test, nonlinearity and asymmetry of cointegration

are accepted. Also, according to the findings of the T-max and  $\Phi$  tests, the cointegration and the long-term nonlinear relationship among the research variables are confirmed. To estimate the research model, the first-order lag of institutional quality was determined as the threshold variable using the threshold regression approach by minimizing the sum of squared errors. Subsequently, the number of model thresholds was examined based on the Schwarz Criterion and Likelihood-Weighted Zero-One statistics. The statistical significance of the threshold was then tested using Hansen's (2000) bootstrap method. Since the asymptotic distribution of the Wald statistic is non-standard under the null hypothesis of linearity, bootstrap procedures were applied to obtain the critical values. The bootstrap involved 10,000 replications to approximate the empirical distribution, and the significance level of the threshold was determined accordingly. Table 4 provides a concise summary of the aforementioned test results.

**Table 4. Results of Threshold Specification**

| Multiple Threshold Tests |                    |        |                   |               |
|--------------------------|--------------------|--------|-------------------|---------------|
| Number of Thresholds     | Sum of Sq. Resides | Log-L  | Schwarz Criterion | LWZ Criterion |
| 0 vs 1*                  | 0.0241             | 75.726 | -6.04             | -5.368        |
| 1 vs 2                   | 0.0869             | 53.373 | -5.014            | -4.716        |
| 2 vs 3                   | 0.1436             | 44.691 | -4.805            | -4.261        |
| Hansen's Linearity Test  |                    |        |                   |               |
| Threshold Value          | F-statistic        |        | Prob              |               |
| 1.2679                   | 9.538              |        | 0.0341            |               |

(Researcher's findings).

According to the findings, the model estimation with one threshold and two regimes was confirmed. Also, the threshold level of institutional quality in the estimated model is 1.2679 at a 5 percent error level, which is significant. According to the standardization of the institutional quality variable, the threshold value refers to the institutional quality at the level of 57 percent. In fact, when the institutional quality variable crosses the 57 percent threshold, the pattern changes from the low institutional quality regime to the high institutional quality regime. Accordingly, the results of the research model estimation are reported in Table 5.

**Table 5. Estimation Results**

| Variable Name          | Coefficient | t-Statistic | Probability Level |
|------------------------|-------------|-------------|-------------------|
| Regime 1: $q < 1.2679$ |             |             |                   |
| $fin_t$                | -0.8244     | -3.961      | 0.0009            |

|                                             |                   |                       |             |
|---------------------------------------------|-------------------|-----------------------|-------------|
| $q_t$                                       | 0.0087            | 2.793                 | 0.0112      |
| $ly_t$                                      | 0.0562            | 14.56                 | 0.0000      |
| <b>Regime 2: <math>q \geq 1.2679</math></b> |                   |                       |             |
| $fin_t$                                     | -1.254            | -6.75                 | 0.0000      |
| $q_t$                                       | 0.027             | 2.45                  | 0.0238      |
| $ly_t$                                      | 0.0681            | 8.18                  | 0.0000      |
| <b>Non-Threshold Variables</b>              |                   |                       |             |
| <b>Intercept</b>                            | -0.33             | -8.39                 | 0.0000      |
| $Tr_t$                                      | 0.296             | 6.83                  | 0.0000      |
| $M_t$                                       | -0.104            | 8.82                  | 0.0000      |
| $H_t$                                       | 0.563             | 2.90                  | 0.0088      |
| $Gi_t$                                      | -1.82             | -7.83                 | 0.0000      |
| $D_t$                                       | -0.0986           | -9.16                 | 0.0000      |
| $R^2 = 0.79$                                | $Adj. R^2 = 0.75$ |                       | $D.W.=2.4$  |
| <b>Diagnostic Tests</b>                     |                   | <b>Test Statistic</b> | <b>prob</b> |
| Normality (Jarque-Bera)                     |                   | 2.097                 | (0.3505)    |
| Serial Correlation (Breusch-Godfrey)        |                   | 1.225                 | (0.3171)    |
| Heteroskedasticity (White)                  |                   | 1.306                 | (0.2896)    |

(Researcher's findings).

The coefficient of R-Squared shows that about 79 percent of the changes in welfare are explained by the independent variables. The small difference between the R-Squared and the adjusted R-Squared indicates the model's goodness of fit. The normality test of the residuals based on the Jarque-Bera statistic specifies that the distribution of sample errors is normal, so the t-statistic and F-statistic are valid in statistical inferences. The results of the Breusch-Godfrey and the White tests show that the estimated model does not have the problem of serial correlation and variance heterogeneity. According to the findings, after the institutional quality improves and it passes the 57 percent threshold, the coefficients of the variables face a structural change. The coefficient of the financialization variable in the first and second regimes is -0.8244 and -1.254, respectively. Therefore, financialization has a negative effect on economic welfare in both regimes. With the difference that after passing the threshold, improving institutional quality increases the intensity of the negative impact of financialization on economic welfare. As the results of various studies show, financialization in Iran is associated with reduced economic growth and increased income inequality. Therefore, the decreasing effect of financialization on economic welfare is understandable. However, the main point is to strengthen the intensity of the undesirable

negative impacts of financialization on welfare. A phenomenon that occurs in weak institutional conditions. These findings highlight the importance of paying attention to the institutional and economic contexts of countries in analyzing the effects of financialization. Institutional quality in both regimes has a positive and significant consequence on economic welfare, and in the high regime, the increasing effect of institutional quality on economic welfare is strengthened. In fact, institutional quality means the growth and development of good governance, and this causes components such as the rule of law, government efficiency in resource distribution, corruption reduction, and political stability to play a more prominent role in the economy. Therefore, improving institutional quality increases welfare more intensely. In both low and high regimes, institutional quality has a positive and significant effect on economic welfare. But, its influence on economic welfare increases in a regime of high institutional quality, meaning that the impact intensity of financialization on welfare is strengthened in the presence of higher institutional quality. In low institutional quality, most of the national income is spent on unproductive plans and projects; public services in the areas of education and health are weak; and even in the presence of significant economic growth, income inequality increases with the concentration of wealth in the hands of certain groups and the emergence of corruption. The enjoyment of the positive impact of growth on welfare is neutralized. On the contrary, in high institutional quality, increased rule of law and political stability lead to efficient allocation of resources in the areas of infrastructure, education, and health; corruption decreases, and, as a result, the positive effects of economic growth are more reflected in the economic welfare of the society. Therefore, the development and improvement of institutional quality is a factor in strengthening the impact of economic growth on welfare. Examining the effects of non-threshold variables further demonstrates that the degree of trade openness is positively and significantly associated with economic welfare.

In fact, increasing trade in goods and services with the outside world, on the one hand, increases the variety and quality of services for consumers, and on the other hand, producers have greater access to larger markets and advanced technology, which increases the welfare of society. The misery index has a significant and decreasing effect on economic welfare. In fact, increasing unemployment coincides with a drop in both income and inflation. This subsequently lowers consumption and service utilization, thereby eroding welfare. Human capital also has a positive and significant effect on welfare, which shows that human capital leads to improved welfare through improved productivity, production growth, and health promotion. Income inequality has a significant and negative effect on welfare. The worsening income distribution through reduced economic growth undermines

national cohesion and fuels crime, which collectively stifles individual talent and sustainable development, thereby threatening societal welfare. Finally, the negative and significant impact of sanctions on welfare shows that sanctions reduce economic growth through various channels, increase inflation, poverty, and inequality, resulting in a decrease in economic welfare.

## 5. Conclusions

The research findings revealed that financialization exerts a nonlinear and diminishing effect on welfare under both low and high institutional quality regimes. However, this negative impact intensifies once institutional quality exceeds a threshold of 57 percent. In the Iranian economy, the attractiveness of investment in the financial sector and the failure to adopt correct policies by the government have caused firms not to reinvest the profits from financial investment in productive activities. Therefore, the process of financialization, along with the tendency to consume imported goods and consequently the decrease in demand for domestic products, economic sanctions, and currency crises, has led to a decrease in production in the real sector and, as a result, a decrease in economic growth in the country. Since the financial sector can't absorb the surplus labor force, employment and consequently the income of the active labor force in the country's real sector have also decreased. One way to compensate and achieve a new source of income for the active labor force in the real sector is to participate in financial markets. Individuals invested their surplus resources in the economy's financial sector, intending to earn income and maintain monetary value by increasing debt or reducing consumption. However, the inefficiency of the financial system, including a lack of access to credit and a lack of information transparency, caused the share of individuals participating in financial markets to be low. Meanwhile, the enjoyment of information rent, high profitability, and overvaluation of financial assets caused individuals and firms active in the financial sector to enjoy increasing returns by investing in financial markets. Therefore, the increase in the income of individuals active in the financial sector, the decrease in the workers' wages in the real sector, and the lack of compensation in financial activities have led to a deterioration in the society's income distribution.

In general, the phenomenon of financialization, along with factors such as the economy's dependence on oil revenues, continuous government budget deficits, unemployment, inflation, inefficiency of government institutions, the imposition of political-economic sanctions, and currency crises, have on the one hand increased the wage gap and income difference between the real and financial sectors, and on the other hand,

have had a negative impact on the country's economic growth by diverting investment towards unproductive activities. As a result, the expansion of financialization has been associated with a decrease in welfare in Iran during the period under study. The findings of the study are consistent with the results of Bhaduri & Oro (2025), Chen & Jiao (2025), and Saha *et al.*, (2025). According to the results of the present study, after the institutional quality crosses the threshold, the severity of the negative effects of financialization on economic welfare increases. This indicates the paradox of institutional quality. That is, in higher institutional quality, advanced financial instruments and capital markets develop, but this access is usually asymmetric. Therefore, the wealthy and large corporations benefit the most, while low-income households have a small share and may even be harmed by rising housing costs, asset inflation, or consumer debt. Strong institutions do not necessarily mean focusing on public welfare. Policymakers may adjust regulations in such a way that the profitability of the financial sector takes priority over social interests to develop financial markets. This can cause financial growth to occur faster than the real capacity of the economy and undermine welfare. Even under strong institutional conditions, if redistributive policies or the financial sector supervision are not adequately designed, the financialization benefits will accrue mainly to high-income groups, and class gaps will widen. This phenomenon often occurs through phenomena such as Over-financialization and the Open Gate Effect. Accordingly, Over-financialization at low levels of institutional quality, the expansion of the financial sector is often associated with inefficiency and rent-seeking, and its negative impact on welfare is clear; but when institutional quality is high, the financial sector becomes more efficient and its size grows faster.

This excessive growth can increase the intensity of the transfer of resources from the real sector (production, employment) to speculative financial activities. The Open Gate Effect implies that strong institutions such as banking regulations, the rule of law, and transparency seemingly provide the conditions for healthy financial development, but in practice, these institutions become tools for facilitating speculative activities. On the one hand, this leads to the emergence of destructive financial flows that only benefit the financial sector of the economy by attracting investor confidence to invest in unproductive and risky projects; on the other hand, financialization generates more profits in the presence of strong institutions, but the profits generated may not be redistributed to the productive sector of the economy under the influence of interest groups such as banks and financial institutions; therefore, strong institutions strengthen the severity of the adverse effects of financialization on real sector growth. In other words, in the presence of stronger institutional quality, the negative effects of financialization on reducing the country's

economic welfare increase. This paradox suggests that institutions designed to reduce risk can, over time, lead to greater diversion of resources and human capital from the real sector to the financial services sector, along with financial development, which reduces the productivity of the real sector of the economy. On the other hand, financialization in the presence of stronger institutions increases the profits of the financial sector and firms, since wages do not increase in proportion to the profits of the financial sector, the wage gap and income inequality reduce welfare. Therefore, even in strong institutions, financial competition and complex innovations can lead to increased inequality, financial instability, and pressure on households. In this regard, the study's findings are consistent with those of Akan and Gunduz (2025), which show the interactive role of institutional quality and financialization in determining welfare. Their research indicates that in countries with high institutional quality, financialization can lead to increased welfare; however, under weak institutional conditions, the effects of financialization are often negative, leading to increased inequality and reduced welfare. These findings highlight the importance of considering countries' institutional and economic contexts when analyzing the effects of financialization.

Since the key components of institutional quality—including Voice and Accountability, Regulatory Quality, and Political Stability—have not experienced significant improvement, the relative enhancement of institutional quality has not reduced the negative impact of financialization on welfare. This matter indicates that in the absence of effective institutional reforms, financial development not only fails to enhance welfare but also may actually be detrimental to it by intensifying speculative behavior, diverting resources from the productive sector, and increasing economic instability. Therefore, considering the potential role of financial institutions in promoting growth and welfare, it is recommended that policymakers adopt appropriate policy measures such as channeling capital into the real economy and preventing the diversion of resources to unproductive activities; restricting short-term corporate behavior through instruments like taxes on share buybacks, mandatory transparency in reporting, and incentives for long-term investment; strengthening financial regulation and systemic risk management; clarifying legal frameworks, reducing information rents, and addressing unequal access in financial markets through public disclosure and anti-corruption regulations; revising the role of supervisory institutions; and enhancing international and regional cooperation to mitigate the adverse effects of sanctions. Such measures can help reduce the negative impact of financialization on economic welfare.

## Acknowledgments

We thank the anonymous reviewers for their useful comments, which greatly contributed to improving our work.

## Observation Contribution

All authors contributed equally to this work.

## Conflict of Interest

The authors declare no conflicts of interest relevant to the content of this article.

## References

- Akan, T. & Gunduz, H. I., (2025). *What Is Financialization?* Routledge.  
<https://doi.org/10.4324/9781003336105>.
- Barradas, R., (2017). "Financialisation and Real Investment in the European Union: Beneficial or Prejudicial Effects?". *Review of Political Economy*, 29(3): 376-413.  
<https://doi.org/0.1080/09538259.2017.1348574>.
- Bhaduri, A. & Oro, G., (2025). "How Inequality Increases Through Financialization". *Journal of Post Keynesian Economics, Review of Political Economy*, 5: 1-17.  
<https://doi.org/10.1080/09538259.2025.2498499>.
- Braga, J. C., Oliveira, G. C. D., Wolf, P. J. W., Palludeto, A. W. A. & Deos, S. S. (2017). "For a Political Economy of Financialization: Theory and Evidence". *Economia e Sociedade, Campinas*, 26(4): 829-856. <http://dx.doi.org/10.1590/1982-3533.2017v26n4art1>.
- Chen, Z. & Jiao, F., (2025). "The Impact of Economic Financialization on the Income Gap Between Urban and Rural Residents: Evidence from China". *Sustainability*, 17: 1-31.  
<https://doi.org/10.3390/su17083484>.
- Doruk, O. T., (2024). "The Dark Side of Finance: the Link Between Financialisation and Labour Investment in Emerging Asian Countries". *Economic Change and Restructuring*, 57(223): 1-18. <https://doi.org/10.1007/s10644-024-09809-4>.
- Epstein, G. A., (2005). *Financialization and the World Economy*. Edward Elgar Publishing. [https://www.depfe.unam.mx/actividades/11/cursos-seccareccia/Epstein\\_Jayadev2005.pdf](https://www.depfe.unam.mx/actividades/11/cursos-seccareccia/Epstein_Jayadev2005.pdf).
- Fioramonti, L., (2017). *Wellbeing Economy: Success in a World Without Growth*. Pan Macmillan. <https://www.amazon.com.au/Wellbeing-Economy-Success-Without-Growth/dp/1770105174>.
- Gabor, D., (2019). "The Wall Street Consensus". *Development and Change*, 52(3): 429–459. <https://doi.org/10.1111/dech.12645>.

- Gutierrez, G. & Philippon T., (2017). “Investmentless Growth: An Empirical Investigation”. *Brookings Papers on Economic Activity*, 2: 89–102. <https://doi.org/10.1353/eca.2017.0013>.
- Hansen, B. E., (2000). “Sample Splitting and Threshold Estimation”. *Econometrica*, 68(3): 575-603. <https://doi.org/10.1111/1468-0262.00124>.
- Izurieta, A., Kohler, P. & Pizarro, J., (2018). “Financialization, Trade, and Investment Agreements: Through the Looking Glass or Through the Realities of Income Distribution and Government Policy?”. *Global Development and Environment Institute working paper*, 18-02, [https://www.bu.edu/eci/files/2020/01/18-02\\_IzurietaKohlerPizarro\\_FinancializationTradeInvestmentAgreements.pdf](https://www.bu.edu/eci/files/2020/01/18-02_IzurietaKohlerPizarro_FinancializationTradeInvestmentAgreements.pdf).
- Krippner, G. R., (2005). “The Financialization of the American Economy”. *Socio-Economic Review*, 3(2): 173–208. <https://doi.org/10.1093/SER/mwi008>.
- Lee, K. & Siddique, M. A. B., (2021). “Financialization and Income Inequality: An Empirical Analysis”. *The Japanese Political Economy*, 47(2-3): 121-145. <https://doi.org/10.1080/2329194X.2021.1945465>.
- Li, K., (2021). “Mechanism of the Effect of Financialization on Economic Growth from the Perspective of Talent Flow”. In: *Proceedings of the 4th International Conference on Economic Management and Green Development*, 387-393. [https://doi.org/10.1007/978-981-16-5359-9\\_44](https://doi.org/10.1007/978-981-16-5359-9_44).
- Lin, K. H. & Tomaskovic-Devey, D., (2013). “Financialization and U.S. Income Inequality, 1970-2008”. *American Journal of Sociology*, 118(5): 1284-1329. <https://doi.org/10.1086/669499>.
- Maaboudi, R. & Dare Nazari, Z., (2021). “The Relation of Financialization With The Income Distribution and Economic Growth in Iran”. *Economics Research*, 21(82): 49-90. <https://doi.org/10.22054/joer.2022.60674.970> (In Persian).
- Mabeba, M., (2024). “The Effect of Financialization on Economic Growth in Developing Countries with Large Financial Sectors”. *International Finance*, 28(4): 218-227. <https://doi.org/10.26794/2587-5671-2024-28-4-218-227>.
- Montgomerie, J. & Büdenbender, M., (2015). “Round the Houses: Homeownership and Failures of Asset-Based Welfare in the United Kingdom”. *New Political Economy*, 20(3): 386–405. <https://doi.org/10.1080/13563467.2014.951429>.
- Osberg, L. & Sharpe, A., (2002). “An Index of Economic Well-Being for Selected OECD Countries”. *Review of Income and Wealth*, 48(3): 291-316. <https://doi.org/10.1111/1475-4991.00056>.
- Saha, M., Dutta, K. D. & Rahman, T., (2025). “Balancing Financialization and Equity: The Crucial Role of Democratic Governance”. *Future Business Journal*, 11: 1-12. <https://doi.org/10.1186/s43093-025-00562-2>.

- Sawyer, M., (2024). "Financial Liberalization and Financial Crisis. Chapter in Financialization: Economic and Social Impacts. Cambridge University Press. <https://doi.org/10.1017/9781911116967.006>.
- Stark, O., (2025). "On A Transformation of the Gini Coefficient into A Well-Behaved Social Welfare Function". *Journal of Kyklos*, 78(2): 301–304. <https://doi.org/10.1111/kykl.12420>
- Stiglitz, J. E., Sen, A. & Fitoussi, J. P., (2009). *Report by the Commission on the Measurement of Economic Performance and Social Progress*. <https://unesdoc.unesco.org/ark:/48223/pf0000206999>.
- Stockhammer, E., (2015). "Determinants of the Wage Share: A Panel Analysis of Advanced and Developing Economies". *British Journal of Industrial Relations*, 7: 1-31. <https://doi.org/10.1111/bjir.12165>.
- van der Zwan, N., (2014). "Making Sense of Financialization". *Socio-Economic Review*, 12(1): 99–129. <https://doi.org/10.1093/ser/mwt020>.
- Vita, G. D. & Luo, Y., (2020). "Financialization, Household Debt and Income Inequality: Empirical Evidence". *International Journal of Finance & Economics in-Press*, 26(2): 1917-1937. <https://dx.doi.org/10.1002/ijfe.1886>.
- Zheng, D., Yang, G., Lei, L. & Li, P., (2025). "Feed-Back Effect or Crowding-Out Effect: The Influence of Financialization on the Main Business Performance of Real Enterprises". *International Review of Economics & Finance*, 98: 103879. <https://doi.org/10.1016/j.iref.2025.103879>.
- Wang, Y. Z. & Zhang, Z. T., (2025). "Digital Development and Rural Financial Inclusion: Evidence from China". *Research in International Business and Finance*, 73(PA): 102637, <https://doi.org/10.1016/j.ribaf.2024.102637>.
- Zhuang, C. & Fangyi, J., (2025). "The Impact of Economic Financialization on the Income Gap Between Urban and Rural Residents: Evidence from China". *Journal of Sustainability*, 17(3484): 1-31. <https://doi.org/10.3390/su17083484>.





**فصلنامه علمی مطالعات اقتصادی کاربردی ایران**  
 چاپی: ۲۵۲۰-۲۳۲۲؛ چاپی الکترونیکی: ۴۷۲۲-۲۳۲۲ - وبسایت نشریه: <https://aes.basu.ac.ir>  
 نشریه گروه اقتصاد، دانشکده علوم اقتصادی و علوم اجتماعی، دانشگاه بوعلی سینا، همدان، ایران.  
 حق انتشار این مستند، متعلق به نویسنده(گان) آن است. ۱۴۰۴ - ناشر این مقاله، دانشگاه بوعلی سینا است.  
 این مقاله تحت گواهی زیر منتشر شده و هر نوع استفاده غیرتجاری از آن مشروط بر استناد صحیح به مقاله و با رعایت شرایط مندرج در آدرس زیر مجاز است.  
 آدرس زیر مجاز است.  
 Creative Commons Attribution-NonCommercial 4.0 International license (<https://creativecommons.org/licenses/by-nc/4.0/>)



## مالی سازی و رفاه در ایران: پارادوکس کیفیت نهادی

رضا معبودی<sup>۱</sup>، رامین خوچیانی<sup>۲</sup>، یونس نادمی<sup>۳</sup>

نوع مقاله: پژوهشی

شناسه دیجیتال: <https://doi.org/10.22084/aes.2025.31450.3820>  
 تاریخ دریافت: ۱۴۰۴/۰۵/۲۹، تاریخ بازنگری: ۱۴۰۴/۰۶/۲۲، تاریخ پذیرش: ۱۴۰۴/۰۶/۲۶  
 صص: ۴۳-۶۵

### چکیده

درک تأثیر مالی سازی بر اقتصاد برای سیاست‌گذارانی که به دنبال طراحی راهبردهایی برای ارتقای رفاه اجتماعی هستند، از اهمیت حیاتی برخوردار است. این پژوهش به بررسی اثر مالی سازی بر رفاه اقتصادی در ایران طی دوره ۱۴۰۲-۱۳۶۹ ه.ش. می‌پردازد و با به‌کارگیری رهیافت رگرسیون آستانه‌ای، پویایی‌های غیرخطی را مدنظر قرار می‌دهد. نتایج، یک سطح آستانه‌ای برای کیفیت نهادی در حد ۵۷٪ نشان می‌دهد. در هر دو رژیم کیفیت نهادی پایین و بالا، مالی سازی تأثیر منفی و معناداری بر رفاه اقتصادی دارد؛ با این حال، زمانی که کیفیت نهادی از این آستانه فراتر رود، اثر نامطلوب مالی سازی به‌طور محسوسی تشدید می‌شود. این یافته‌ها نقش متناقض کیفیت نهادی را برجسته می‌سازد و نشان می‌دهد که مالی سازی بیشتر به‌طور پیوسته رفاه در ایران را تضعیف می‌کند و نهادهای قوی‌تر، به جای کاهش، بر اثرات منفی آن می‌افزایند. به این معنا که در کیفیت نهادی بالاتر، ابزارهای مالی پیشرفته و بازار سرمایه توسعه می‌یابد؛ اما این دسترسی معمولاً نامتقارن است؛ از این رو، اقشار ثروتمند و شرکت‌های بزرگ بیشترین بهره را می‌برند، درحالی که خانوارهای کم‌درآمد سهم اندکی دارند و حتی ممکن است از افزایش هزینه مسکن، تورم دارایی، یا بدهی مصرفی آسیب ببینند.

**کلیدواژگان:** مالی سازی، رفاه اقتصادی، کیفیت نهادی، رویکرد رگرسیون آستانه، ایران.

**طبقه‌بندی JEL:** I31, G10, O16, E44.

۱. دانشیار گروه اقتصاد، دانشکده علوم انسانی، دانشگاه آیت الله بروجردی (ره)، بروجرد، ایران (نویسنده مسئول).  
**Email:** [maaboudi@abru.ac.ir](mailto:maaboudi@abru.ac.ir)

۲. دانشیار گروه اقتصاد، دانشکده علوم انسانی، دانشگاه آیت الله بروجردی (ره)، بروجرد، ایران.  
**Email:** [khochiany@abru.ac.ir](mailto:khochiany@abru.ac.ir)

۳. دانشیار گروه اقتصاد، دانشکده علوم انسانی، دانشگاه آیت الله بروجردی (ره)، بروجرد، ایران.  
**Email:** [Younesnademi@abru.ac.ir](mailto:Younesnademi@abru.ac.ir)



**Applied Economics Studies, Iran (AESI)**P. ISSN:2322-2530 & E. ISSN: 2322-472X - Journal Homepage: <https://aes.basu.ac.ir/>

Scientific Journal of Department of Economics, Faculty of Economic and Social Sciences, Bu-Ali Sina University, Hamadan, Iran. Owner &amp; Publisher: Bu-Ali Sina University.

© Copyright © 2025 The Authors. Published by Bu-Ali Sina University.

This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International license (<https://creativecommons.org/licenses/by-nc/4.0/>). Non-commercial uses of the work are permitted, provided the original work is properly cited.

# Investigating the Impact of Uncertainty in Influential Factors on the Ecological Footprint in Selected Asian and European Countries

Masoud Cheshmaghil<sup>1</sup> , Javad Shahraki<sup>2</sup> , Reza Ashraf Ganjoei<sup>3</sup> 

Type of Article: Research

 <https://doi.org/10.22084/aes.2025.31000.3796>

Received: 2025/05/19; Revised: 2025/08/08; Accepted: 2025/08/27

Pp: 67-91

## Abstract

The ecological footprint is an effective tool for evaluating the pressures exerted on ecosystems and the environment. Given its importance, the present study examines the impact of uncertainty in factors influencing the ecological footprint across 10 selected Asian and European countries. To this end, a fuzzy regression model was employed to analyze these effects during the period from 1996 to 2022. Leveraging the capabilities of fuzzy regression, the intensity of each factor's influence on the ecological footprint was calculated in terms of fuzzy centers, left spreads, and right spreads. The findings reveal that Gross Domestic Product (GDP) in Iran (+5.5 and -4.5) had the most significant negative environmental impact, attributable to oil dependence and insufficient attention to environmental concerns. In contrast, China (+0.29 and -0.23) demonstrated improvements due to greener policies. Regarding trade (EX), Azerbaijan and Malaysia exhibited asymmetric effects due to their reliance on natural resource exports, whereas Romania (stable at 0.37) maintained more sustainable performance owing to European regulatory standards. Financial Development (FDI) showed high volatility in China ( $\pm 6.13$ ) and Thailand (+2.77 and -2.34), while Belarus (stable at 0.24) had the least impact. Hydropower energy consumption (HP) in Türkiye and Romania faced uncertainties due to large-scale projects, whereas Russia (stable at 0.007) played a minimal role. The key conclusion indicates that resource-dependent countries (e.g., Iran and Azerbaijan) exert greater environmental pressure, whereas economies with diversification (e.g., China) or strict regulatory standards (e.g., Romania) achieve better integration of economic growth and sustainability. These findings underscore the need for revising development policies to prioritize ecological balance.

**Keywords:** Ecological footprint, Uncertainty, Hydropower Energy, Asian and European Countries.

**JEL Classification:** Q56, C18, Q42, O52.

1. PhD Candidate in Public Sector Economics, Department of Economics, Faculty of Economics and Administrative Sciences, University of Siستان and Baluchestan, Zahedan, Iran.

2. Associate Professor, Department of Economics, Faculty of Economics and Administrative Sciences, University of Siستان and Baluchestan, Zahedan, Iran (Corresponding Author). **Email:** [j.shahraki@eco.usb.ac.ir](mailto:j.shahraki@eco.usb.ac.ir)

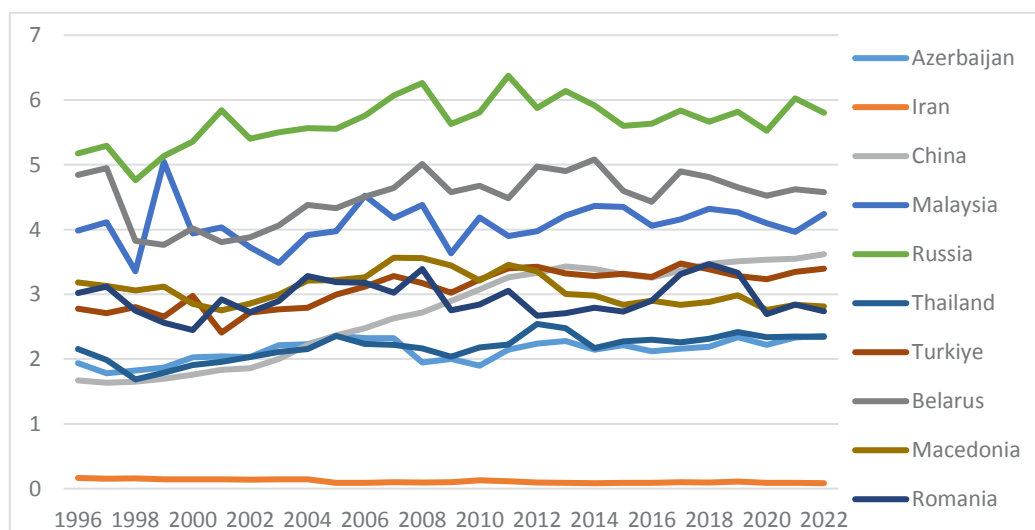
3. Assistant Professor, Department of Economics, Faculty of Economics and Administrative Sciences, University of Siستان and Baluchestan, Zahedan, Iran.

**Citations:** Cheshmaghil, M., Shahraki, J. & Ashraf Ganjoei, R., (2025). "Investigating the Impact of Uncertainty in Influential Factors on the Ecological Footprint in Selected Asian and European Countries". *Journal of Applied Economics Studies in Iran*, 14(55): 67-91. <https://doi.org/10.22084/aes.2025.31000.3796>

**Homepage of this Article:** [https://aes.basu.ac.ir/article\\_6224.html?lang=en](https://aes.basu.ac.ir/article_6224.html?lang=en)

## 1. Introduction

The ecological footprint is defined as a composite metric for assessing the balance between environmental supply and demand. First introduced by [Rees & Wackernagel \(1997\)](#), this concept is grounded in the principle that human activities impact the environment because they rely on nature's resources and services to meet their needs. By definition, the ecological footprint represents the amount of natural and ecological resources required to sustain an individual's lifestyle. Broadly, the footprint humans leave on the environment includes deforestation, grassland degradation, air pollution, and harm to wildlife. Measured in global hectares (gha)—a unit equivalent to one hectare of land with average global productivity—this metric is essential for environmental decision-making. The present study examines the impact of uncertainty on ecological footprint dynamics in selected Asian and European countries. Here, uncertainty is treated as a key variable, quantified based on indicators of economic instability and fluctuations in environmental policies. These indicators are modeled fuzzily to account for inherent ambiguities in measuring uncertainty. The fuzzy regression approach adopted in this research provides a robust framework for analyzing uncertainty's influence on the ecological footprint. Unlike deterministic models, this method considers a range of possible values for each variable (rather than a fixed value), enabling the evaluation of diverse scenarios. Specifically, the fuzzy method calculates the "impact width" of each factor (including uncertainty) on the ecological footprint, reflecting the degree of ambiguity in these relationships. Thus, our model assesses both the direction and intensity of uncertainty's effects under varying economic and environmental conditions. To contextualize these impacts, we first analyze trends in ecological footprints across the studied countries.



**Fig. 1: Trend of Ecological Footprint in Selected Asian and European Countries**

According to data from the Global Footprint Network (2023), Figure 1 demonstrates that Russia has the highest ecological footprint at 6.73 global hectares per capita (gha/capita), primarily due to its heavy reliance on oil and gas industries and inefficient natural resource management. Belarus ranks second with 5.92 gha/capita, reflecting the detrimental impact of Soviet-era heavy industries. Malaysia follows in third place with 5.45 gha/capita, resulting from unsustainable palm oil production and tourism development. Notably, China shows improvement at 5.21 gha/capita despite its large population, owing to investments in renewable energy. Turkey (4.89 gha/capita), facing water crises from large infrastructure projects, and North Macedonia (3.76 gha/capita) with outdated heating systems, occupy subsequent positions. Despite EU membership, Romania (3.52 gha/capita) performs poorly due to coal dependence and deforestation. Thailand (3.21 gha/capita) struggles with tourism-related plastic pollution, Azerbaijan (2.95 gha/capita) with oil-dependent mono-economy, and Iran (2.83 gha/capita) with excessive energy consumption and water scarcity, completing the ranking ([World Bank, 2022](#); [UNEP, 2023](#)). These trends clearly indicate that energy consumption patterns and natural resource management are the most decisive factors in national ecological footprints.

Considering the critical role of energy consumption patterns in ecological footprint calculations, renewable energy sources - particularly hydropower - emerge as a key factor warranting in-depth examination. The examination of factors affecting ecological footprint has consistently been a compelling subject in environmental economics. Hydropower consumption, as one such factor, has increased significantly with economic activity. While hydropower serves as a renewable resource that effectively reduces air pollution, its expanded generation and consumption may substantially decrease pollution levels. However, extensive use of both renewable and non-renewable energy sources can increase ecological footprints. Nevertheless, renewables generally have fewer environmental impacts than non-renewables, making them preferable for achieving environmental sustainability (Nathaniel and Khan, 2020). Although hydropower offers significant advantages, its environmental consequences should not be overlooked. Despite its benefits of renewability and low-carbon production, hydropower carries notable environmental consequences. Large reservoir construction can destroy natural ecosystems, eliminate forests and wetlands, and displace communities. These reservoirs render natural habitats unusable for flora and fauna while disrupting river flows, particularly harming migratory fish species. Changes in sediment and oxygen levels degrade aquatic habitats and threaten species survival. Additionally, submerged forests in reservoirs generate methane from anaerobic decomposition of organic matter, increasing greenhouse gas emissions - an effect

more pronounced in tropical regions. Organic and sediment accumulation also reduces water quality and compromises dam functionality, requiring increased maintenance. In addition to hydropower, other macroeconomic variables affecting the ecological footprint have been considered in this study. Other significant variables affecting ecological footprint include per capita GDP, financial development, trade openness, among others, which have been explored in various studies and are examined in this research.

Today, rapid economic growth and industrial development in many countries have placed unprecedented pressure on natural resources and the environment. The ecological footprint, as a comprehensive indicator for measuring these pressures, reveals that current development patterns in many countries—particularly those dependent on natural resources—are unsustainable and pose a serious threat to natural ecosystems. Despite numerous studies on factors affecting the ecological footprint, the impact of economic uncertainties on this indicator and its cross-country variations have received less attention. Yet, economic fluctuations, policy changes, and macroeconomic instabilities can significantly alter the relationship between economic growth and environmental pressures. Accurately identifying the factors influencing the ecological footprint under uncertain conditions is crucial for formulating effective sustainable development policies. This study combines ecological footprint analysis with economic uncertainty to provide a more comprehensive framework for understanding these relationships. By employing fuzzy regression methods and examining selected countries at different development levels, the research offers deeper insights into the complex interplay between economic and environmental variables. The findings can assist policymakers in developing countries in designing strategies to mitigate environmental pressures while accounting for uncertainty effects. Additionally, comparing the performance of different countries may help identify successful models for reconciling economic growth with environmental sustainability. Therefore, this study aims to measure the impact of uncertainty in ecological footprint determinants across selected Asian and European countries (Iran, Azerbaijan, China, Russia, Malaysia, Thailand, Turkey, Belarus, North Macedonia, and Romania) through fuzzy analysis of right and left spreads. This methodology enables precise determination of each factor's influence on ecological footprint. This study employs fuzzy regression analysis as a novel and robust methodological approach for ecological footprint assessment, offering distinct advantages over conventional techniques. The selected methodology demonstrates particular efficacy in modeling complex nonlinear relationships among variables, accommodating varying degrees of membership, and processing incomplete or uncertain datasets, making it exceptionally well-suited for analyzing the

multidimensional nature of ecological footprint dynamics. The principal innovation of this research lies in its application of fuzzy regression to concurrently examine economic and environmental determinants, thereby enabling the investigation of uncertainty both as an independent variable and as an intrinsic system property. A critical methodological advantage is the generation of interval-based outputs, which facilitates scenario analysis by policymakers - a particularly crucial capability for environmental assessments characterized by inherent uncertainties. Methodologically, this approach represents a significant advancement by enabling: (1) integrated analysis of qualitative and quantitative variables, (2) explicit incorporation of uncertainty as a system component, and (3) comprehensive modeling of nonlinear relationships, collectively providing a more nuanced and realistic representation of the complex interplay between economic and environmental variables than previous research frameworks. The paper comprises five sections: following the introduction, Section 2 reviews existing literature; Section 3 details the model and methodology; Section 4 presents empirical data analysis and results; and Section 5 provides conclusions and policy recommendations.

## **2. Theoretical Foundations of the Research**

### **2-1. Impact of GDP on Environmental Quality**

Numerous studies have demonstrated that the relationship between per capita GDP and environmental quality follows the Environmental Kuznets Curve (EKC) pattern. In the early stages of economic growth, countries typically focus on industrial development and increased production, leading to greater exploitation of natural resources and higher consumption of fossil fuels. This process is associated with rising pollution levels and environmental degradation ([Selden & Song, 1994](#)). However, after reaching a certain per capita income threshold (typically in developed countries), public demand for a cleaner environment increases, and stricter regulatory policies are implemented. At this stage, investments in clean technologies and energy efficiency improvements lead to reduced pollution and enhanced environmental quality ([Grossman & Krueger, 1991](#)). Studies such as [Cole et al., \(1997\)](#) further emphasize that strong institutions and effective environmental policies can shift the EKC's turning point to lower per capita income levels.

### **2-2. Impact of Financial Development on Environmental Quality**

Financial development—defined as the improvement in the quantity, quality, and efficiency of financial intermediation services—has dual effects on the environment. On one hand, by facilitating access to capital, financial development enables the expansion of

industrial and manufacturing activities, which may increase energy consumption and pollutant emissions (Sadorsky, 2010). On the other hand, it reduces financing costs, promoting investments in environmental projects and clean technologies (Tamazian & Bhaskara, 2010). Additionally, developed financial markets can introduce innovative instruments such as green bonds and low-interest credits for sustainable projects, thereby reducing ecological footprints. Thus, the environmental impact of financial development depends on a country's economic structure, policy orientation, and regulatory institutions.

### 2-3. Impact of Trade on Environmental Quality

International trade affects environmental quality through three primary mechanisms: the scale effect, composition effect, and technique effect. The scale effect refers to increased economic activity due to trade expansion, which may raise resource consumption and pollution. The composition effect relates to shifts in production structures based on comparative advantages—e.g., specialization in energy-intensive goods may increase pollution, while knowledge-based production reduces environmental harm. The technique effect captures technology transfers and efficiency gains from trade (Grossman & Krueger, 1991). If the technique effect dominates, trade can improve environmental quality. Furthermore, international trade agreements incorporating environmental clauses may amplify these positive effects.

### 2-4. Impact of Energy on Environmental Quality

Energy consumption, particularly fossil fuels, is a key driver of ecological footprint growth (Charfeddine & Mrabet, 2017). Rising energy use increases greenhouse gas emissions and other pollutants, degrading air, water, and soil quality. However, transitioning to renewables (e.g., hydropower, solar, wind) can mitigate these impacts. Studies show that expanding clean energy shares not only reduces emissions but also fosters low-consumption, sustainable production processes. Energy policies such as environmental taxes and clean energy subsidies further incentivize efficiency and decarbonization.

## 3. Empirical Studies

### 3-1. Domestic Empirical Studies

Shad Stanjin & Safarzadeh (2022) analyzed the short-term and long-term relationship between hydropower consumption and environmental degradation indicators (ecological footprint, carbon footprint, and CO<sub>2</sub> emissions) in Iran's economy from 1980 to 2018.

Results revealed significant negative relationships between hydropower consumption and both CO<sub>2</sub> emissions and carbon footprint across both time horizons. Hydropower also demonstrated short-term positive effects on reducing ecological footprint. [Esfahani et al., \(2022\)](#) examined the nexus between economic growth, energy consumption, and ecological footprint across 72 developed and developing countries (1990-2018) using Generalized Method of Moments (GMM). Findings indicate bidirectional relationships between economic growth and both energy consumption/ecological footprint in both country groups. Non-renewable energy consumption, urbanization, fertility, and mortality rates positively increase ecological footprint, while renewable energy, technological progress, and human capital reduce it. Economic growth decreases ecological footprint in developed nations but increases it in developing countries, reflecting greater renewable energy adoption in developed economies. Interestingly, ecological footprint negatively impacts economic growth in developed nations while showing positive effects in developing contexts. [Mohammadi-Nia et al., \(2024\)](#) employed a Nonlinear ARDL (NARDL) model to investigate asymmetric relationships between globalization, economic growth, financial development, and ecological footprint in Iran (1981-2021). Results demonstrate symmetric long-term effects of globalization and financial development shocks on ecological footprint, but asymmetric effects for economic growth, confirming nonlinear dynamics. Financial development showed significant positive impacts on ecological footprint.

### 3-2. International Empirical Studies

[Liu and Kim's \(2018\)](#) Panel VAR analysis of 44 Belt and Road countries (1990-2016) revealed unidirectional causality from ecological footprint to FDI, supporting the Pollution Haven Hypothesis (PHH) for both FDI and GDP, with notable heterogeneity among variables. [Nathaniel's \(2020\)](#) study on Indonesia identified urbanization, economic growth, and energy consumption as drivers of environmental degradation, while trade showed long-term negative environmental impacts. Results confirmed unidirectional causality from economic growth to ecological footprint and from urbanization to energy consumption. In their 2022 study, Radmehr et al., employed the Generalized Method of Moments (GMM) to analyze the tripartite relationships among ecological footprint, renewable energy consumption, and income across G7 nations from 1990 to 2018, revealing significant bidirectional linkages: their findings not only demonstrate mutual causality between GDP and renewable energy but also confirm reciprocal relationships between ecological footprint and both GDP and renewable energy consumption, highlighting the complex interdependencies among economic growth, clean energy adoption, and environmental

impacts in advanced economies. [Irina Georgescu and Jani Kinunen's \(2023\)](#) ARDL analysis of Finland (1990-2021) found GDP and FDI significantly reduced ecological footprint, while energy consumption increased it, validating an Environmental Kuznets Curve (EKC) relationship. [Khan et al., \(2023\)](#) investigated the dynamic relationships between urbanization, energy consumption, and environmental pollution in India during the 1971-2018 period. Their study employed the nonlinear autoregressive distributed lag (NARDL) cointegration test developed by [Shin et al., \(2014\)](#) to analyze these dynamic interactions. The findings reveal that while urbanization has proven environmentally beneficial in India's long-term development, energy consumption has consistently exerted harmful environmental effects. Notably, both positive and negative shocks from energy use and urbanization demonstrate asymmetric impacts on ecological footprint. [Aldegheishem \(2024\)](#) extended this research focus by examining how urbanization, energy consumption, natural resources, economic growth, and technological innovation affect ecological footprint in Saudi Arabia (1990-2022). Utilizing multinational data sources, the empirical results demonstrate consistent patterns across both short- and long-term analyses: urbanization, natural resource abundance, and technological innovation significantly reduce ecological footprint, whereas energy consumption and economic growth contribute to its expansion. These contrasting effects highlight the complex environmental trade-offs accompanying development processes.

#### 4. Methodology

Fuzzy regression models were first introduced by [Tanaka et al., \(1982\)](#). These models obtain the optimal regression equation by minimizing the degree of fuzziness, achieved through minimizing the sum of the membership function widths of the fuzzy coefficients in the equation. Fuzzy regression models possess distinct characteristics compared to classical regression models. Classical regression requires a set of strong statistical assumptions for valid results, including: Normality of errors, Absence of autocorrelation & Homoscedasticity (constant error variance).

Violation of any of these assumptions can significantly undermine the validity of classical regression analyses. In many cases, justifying these assumptions is difficult or the necessary conditions for their application may not be properly met. For instance, observations or system definitions may be influenced by insufficient information or imprecise human judgments. Although classical regression has wide applications, it may produce misleading results under the following conditions: Insufficient observational data,

Non-normal error distributions, Ambiguity in relationships between independent and dependent variables, Uncertainty regarding events & Invalid linearization assumptions.

When classical regression methodology and its assumptions are difficult to justify, fuzzy regression can serve as a more effective tool. This approach utilizes membership functions and possibility distributions to model imprecise or ambiguous conditions, enabling better system understanding and more accurate results. In classical regression, a specific output value is computed for each set of input variables, whereas fuzzy regression estimates a range of possible outputs whose distribution is defined by membership functions.

Three main categories of fuzzy regression models exist: Possibilistic fuzzy regression models, Least squares fuzzy regression models & Interval analysis-based regression models.

This study employs possibilistic fuzzy regression. To achieve optimal fitting, an optimal model must be estimated. Since the membership functions used to represent fuzzy numbers are triangular, fuzzy regression can be formulated as a linear programming problem. One type of possibilistic fuzzy regression model uses fuzzy coefficients with non-fuzzy input and observed output. The general form of the fuzzy regression model with fuzzy coefficients is shown in Equation (1):

$$\tilde{Y} = f(x, A) = \tilde{A}_0 + \tilde{A}_1 x_1 + \tilde{A}_2 x_2 + \dots + \tilde{A}_n x_n \quad (1)$$

Where:

$\tilde{Y}$  is the fuzzy dependent variable (output)

$x = (x_1, x_2, \dots, x_n)$  is the vector of independent variables (input)

$A = \{\tilde{A}_0, \tilde{A}_1, \dots, \tilde{A}_n\}$  is a set of fuzzy numbers

The fuzzy linear regression model with fuzzy parameters, non-fuzzy inputs, and fuzzy output is formulated as a linear programming problem aimed at minimizing the ambiguity of the fuzzy linear regression model, ensuring that the estimated value range covers the observed value range at a specified level. In this study, regression coefficients are defined as triangular fuzzy numbers:

$$\tilde{A}(x) = \begin{cases} 1 - \frac{a-x}{s^L} & a - s^L \leq x \leq a \\ 1 - \frac{x-a}{s^R} & a < x \leq a + s^R \end{cases} \quad (2)$$

Where:  $a$  is the central value

$s^L$  and  $s^R$  are the left and right widths of  $\tilde{A}$ , respectively

When  $s^L \neq s^R$ , the triangular fuzzy number  $\tilde{A}$  is called asymmetric. In this case, the membership function  $\tilde{A}$  can alternatively be expressed in terms of three parameters ( $a, s^L,$

$s^R$ ) by expressing the right width in terms of the left width. Letting  $s^R = ks^L$ , where  $k$  is a positive real number called the stretch coefficient, the asymmetric triangular fuzzy number  $\tilde{A}$  can be described by the triple  $[\tilde{A} = (a, s^L, k)]_T$ , and its membership function becomes:

$$\tilde{A}(x) = \begin{cases} 1 - \frac{a-x}{s^L} & a - s^L \leq x \leq a \\ 1 - \frac{x-a}{ks^R} & a < x \leq a + ks^R \end{cases} \quad (3)$$

Accordingly, the fuzzy output  $\tilde{Y}$  is also an asymmetric triangular fuzzy number:

$$\begin{aligned} f^c(\underline{x}) &= a_0 + a_1 x_1 + \dots + a_n x_n \\ f_s^L(\underline{x}) &= s_0^L + s_1^L x_1 + \dots + s_n^L x_n \\ f_s^R(\underline{x}) &= s_0^R + s_1^R x_1 + \dots + s_n^R x_n \end{aligned} \quad (4)$$

Where:

$$\begin{aligned} f^c(\underline{x}) &= a_0 + a_1 x_1 + \dots + a_n x_n \\ f_s^L(\underline{x}) &= s_0^L + s_1^L x_1 + \dots + s_n^L x_n \\ f_s^R(\underline{x}) &= s_0^R + s_1^R x_1 + \dots + s_n^R x_n \end{aligned} \quad (4)$$

The membership function of  $\tilde{Y}$  can thus be expressed as:

$$\tilde{Y}(y) = \begin{cases} 1 - \frac{f^c(\underline{x}) - y}{f_s^L(\underline{x})}, & f^c(\underline{x}) - f_s^L(\underline{x}) \leq y \leq f^c(\underline{x}) \\ 1 - \frac{y - f^c(\underline{x})}{f_s^R(\underline{x})}, & f^c(\underline{x}) < y \leq f^c(\underline{x}) + f_s^R(\underline{x}) \end{cases} \quad (5)$$

In fuzzy regression, the objectives are:

Ensure all fuzzy output values  $\tilde{Y}_j$  ( $j = 0, 1, 2, \dots, m$ ) have membership degrees of at least  $h$ :

$$\tilde{Y}_j(\tilde{y}_j) \geq h, \quad i = 1, 2, \dots, m \quad (6)$$

Determine fuzzy coefficients  $\tilde{A}_i$  ( $i = 0, 1, 2, \dots, n$ ) that minimize the output's fuzziness.

For symmetric  $\tilde{A}_i$  ( $i = 0, 1, \dots, n$ ), the objective function (sum of output fuzzy widths for all data) is:

$$Z = 2ms_0 + 2 \sum_{i=1}^n (s_i \sum_{j=1}^m x_{ji}) \quad (7)$$

Where  $x_{ji}$  represents the  $j$ -th observation of the  $i$ -th variable. For asymmetric  $\tilde{A}_i$ ,  $Z$  becomes:

$$\mathbf{Z} = \mathbf{m}(\mathbf{s}_0^L + \mathbf{s}_0^R) + \sum_{i=1}^n [(\mathbf{s}_0^L + \mathbf{s}_0^R) \sum_{j=1}^m \mathbf{x}_{ji}] \quad (8)$$

For symmetric  $\tilde{A}_i$  ( $i = 0, 1, 2, \dots, n$ ), substituting Equation (4) into (10) and (5) yields the constraints:

$$(1 - h)\mathbf{s}_0 + (1 - h) \sum_{i=1}^n (\mathbf{s}_0 \mathbf{x}_{ji}) - \mathbf{a}_0 - \sum_{i=1}^n (\mathbf{s}_0 \mathbf{x}_{ji}) \geq -\mathbf{y}_i, j = 1, 2, \dots, m \quad (9)$$

$$(1 - h)\mathbf{s}_0 + (1 - h) \sum_{i=1}^n (\mathbf{s}_0 \mathbf{x}_{ji}) + \mathbf{a}_0 + \sum_{i=1}^n (\mathbf{s}_0 \mathbf{x}_{ji}) \geq +\mathbf{y}_i, j = 1, 2, \dots, m \quad (10)$$

Where  $\mathbf{x}_{ji}$  represents the  $j$ -th observation of the  $i$ -th variable. Based on the above explanations, the right and left widths are calculated for a membership degree of 0.9 (Cheshmaghil *et al.*, 2024).

The fuzzy regression method was selected for this study due to its capability to model inherent data uncertainties and complex inter-variable relationships. While classical regression relies on restrictive assumptions such as error normality and homoscedasticity, fuzzy regression employs asymmetric triangular membership functions to represent interval-valued possibilities, offering greater flexibility when handling imprecise or incomplete data. By minimizing model ambiguity (through linear programming) while guaranteeing a minimum membership degree ( $h=0.9$ ), this approach yields more reliable results under real-world conditions—making it better suited for our research problem than conventional methods.

## 5. Data and Results

This study examines the impact of uncertainty factors on ecological footprint in selected Asian and European countries (Iran, Azerbaijan, China, Malaysia, Russia, Thailand, Turkey, Belarus, North Macedonia, and Romania) using annual data from 1996 to 2022. The study population comprises 10 selected Asian and European countries classified as upper-middle-income economies according to World Bank statistics. Within this category, Europe includes 13 countries and Asia 7 countries. Nations such as Iraq, Jordan, Lebanon, Albania, Bosnia, Bulgaria, Georgia, Kazakhstan, Montenegro, and Serbia were excluded

due to insufficient data on ecological footprint and GDP. Consequently, the final sample consists of Iran, Azerbaijan, China, Malaysia, Russia, Thailand, Turkey, Belarus, North Macedonia, and Romania. Per capita ecological footprint data were obtained from the Global Footprint Network, while macroeconomic variables including per capita GDP, energy consumption, financial development, and trade openness were collected from the World Bank's World Development Indicators (WDI) for the period 1996-2022. As noted, the selected countries fall under the upper-middle-income category based on the World Bank's 2017 classification using gross national income (GNI) per capita, reflecting comparable levels of economic development, production capacity, and macroeconomic challenges. Although geographical and social differences exist, their similar income levels lead to shared challenges such as transitioning to advanced technology-based economies, attracting foreign direct investment, and improving labor productivity. The study period covers years when these countries experienced significant global developments (e.g., financial crises and commodity price fluctuations), making their policy responses comparable. Thus, despite apparent diversity, focusing on this group is methodologically justified due to their homogeneity in key economic indicators. The fuzzy regression model was estimated using MATLAB software. Following the studies of [Elnour et al., \(2022\)](#), [Rahman et al., \(2021\)](#), and [Nathaniel et al., \(2020\)](#), the model is specified as:

$$ECFP = F(GDP, GDP^2, EX, FDI, HP) \quad (11)$$

In this section, a fuzzy regression with symmetric coefficients will be estimated to examine the impact of the uncertainty of per capita GDP (GDP), squared per capita GDP ( $GDP^2$ ), trade openness (EX), financial development (FDI), and hydropower energy consumption (HP) on the ecological footprint (ECFP) in selected Asian and European countries. The 26-year study period (1996-2022) includes 52 constraints for minimizing the objective function to assess ecological footprint uncertainty. All computations were performed in MATLAB. After establishing the constraints, the optimization problem was solved using symmetric fuzzy coefficients with a 0.9 membership level, calculating: Fuzzy center values, Right fuzzy spreads & Left fuzzy spreads

**Table 1: Fuzzy Estimation of the Impact Width of Factors Affecting the Ecological Footprint in Iran**

| Variable Name | Left Width | Average Width | Right Width |
|---------------|------------|---------------|-------------|
| GDP           | -4.500     | 0.500         | 5.500       |
| $GDP^2$       | -8.570E-14 | 1.288E-15     | 8.288E-14   |
| EX            | -1.406E-14 | 1.552E-15     | 1.716E-14   |

|     |            |           |           |
|-----|------------|-----------|-----------|
| FDI | -1.567E-13 | 2.084E-15 | 1.609E-13 |
| HP  | -5.838E-13 | 3.281E-14 | 6.495E-13 |

The results from Table (1) indicate that per capita GDP (GDP) in Iran shows the highest level of uncertainty in its impact on ecological footprint, with a right spread of 5.5 and left spread of -4.5, reflecting the asymmetric effect of economic growth on the environment, which is likely due to Iran's heavy reliance on oil industries and insufficient consideration of environmental factors in development planning. The squared GDP (GDP<sup>2</sup>) demonstrates negligible impact on ecological footprint with values close to zero, suggesting that the relationship between economic growth and environmental degradation has not yet reached saturation point. Trade openness (EX) shows minimal influence on Iran's ecological footprint index with very small coefficients, potentially indicating the unique nature of Iran's foreign trade that primarily relies on crude oil exports. Financial development (FDI), despite high uncertainty, exhibits moderate impact, likely due to structural limitations in attracting foreign investment. Hydropower consumption (HP) displays wide spreads but moderate effects, revealing the insignificant share of renewable energy in the country's energy portfolio. These findings collectively demonstrate that Iran's economic growth pattern exerts substantial pressure on the environment, necessitating a fundamental revision of development policies with greater emphasis on environmental considerations.

**Table 2: Fuzzy Estimation of the Impact Width of Factors Affecting the Ecological Footprint in Azerbaijan**

| Variable Name    | Left Width | Average Width | Right Width |
|------------------|------------|---------------|-------------|
| GDP              | -1.231     | 3.020E-16     | 1.231       |
| GDP <sup>2</sup> | -2.921E-15 | 1.728E-16     | 3.267E-15   |
| EX               | -1.385     | 0.461         | 2.307       |
| FDI              | -1.748     | 0.089         | 1.927       |
| HP               | 0.332      | 0.332         | 0.332       |

In Azerbaijan, per capita GDP (GDP) demonstrates a more balanced impact on ecological footprint with a symmetric spread of  $\pm 1.231$ , likely attributable to the relative diversity in the country's economic structure. In contrast, squared GDP (GDP<sup>2</sup>) shows negligible influence on ecological footprint, indicating a linear relationship between economic growth and environmental pressure. Trade openness (EX) exhibits significant asymmetric effects on the ecological footprint index with a right spread of 2.307 and left spread of -1.385, which may stem from Azerbaijan's heavy reliance on oil and gas exports.

Financial development (FDI) displays high uncertainty (right spread: 1.926; left spread: -1.748), probably linked to oil price volatility and its impact on investment attraction. Hydropower consumption (HP) has a relatively small but definitive effect (constant value: 0.332) on the dependent variable, reflecting development constraints in this sector. These results collectively indicate that while Azerbaijan maintains a more balanced situation compared to Iran, its continued dependence on extractive industries still exerts considerable pressure on the country's environment.

**Table 3: Fuzzy Estimation of the Impact Width of Factors Affecting the Ecological Footprint in China**

| Variable Name    | Left Width | Average Width | Right Width |
|------------------|------------|---------------|-------------|
| GDP              | -0.234     | 0.028         | 0.291       |
| GDP <sup>2</sup> | -0.358     | 1.441E-10     | 0.358       |
| EX               | 0.183      | 0.183         | 0.183       |
| FDI              | -6.138     | 1.246E-09     | 6.138       |
| HP               | -0.287     | 2.464E-10     | 0.287       |

The results from Table (3) for China indicate that per capita GDP (GDP) has a relatively balanced impact on the ecological footprint index with a right spread of 0.29132 and left spread of -0.234, likely reflecting China's recent policies integrating economic growth with environmental considerations. Squared GDP (GDP<sup>2</sup>) shows greater uncertainty with a symmetric spread of  $\pm 0.358$ , which may stem from regional differences in implementing environmental policies. Trade openness (EX) has a stable but minor effect on ecological footprint with a constant value of 0.183. Financial development (FDI) displays the highest level of uncertainty ( $\pm 6.138$ ), clearly related to the massive scale and diversity of foreign investments in China. Hydropower consumption (HP) has a moderate impact with symmetric spread of  $\pm 0.287$ , probably indicating the complex effects of large-scale hydropower projects. These findings collectively suggest that while China has taken significant steps toward aligning economic growth with environmental protection, notable challenges remain, particularly in managing foreign investments and large infrastructure projects.

**Table 4: Fuzzy Estimation of the Impact Width of Factors Affecting the Ecological Footprint in Malaysia**

| Variable Name | Left Width | Average Width | Right Width |
|---------------|------------|---------------|-------------|
| GDP           | -3.565E-09 | 2.674E-10     | 4.100E+09   |

|       |            |           |           |
|-------|------------|-----------|-----------|
| GDP^2 | -5.409E-09 | 3.039E-10 | 6.017E-09 |
| EX    | -0.725     | 0.587     | 1.899     |
| FDI   | -4.817     | 0.458     | 5.733     |
| HP    | -1.655     | 1.847E-10 | 1.655     |

The results of Table (4) for Malaysia show that per capita GDP (GDP) exhibits significant uncertainty with a very large right spread (4.100E+09) and left spread (-3.565E-09), likely due to Malaysia's unique economic mix of industry, services and agriculture. Squared GDP (GDP<sup>2</sup>) also shows high uncertainty with a right spread of 6.017E-09 and left spread of -5.409E-09. Trade openness (EX) demonstrates notable asymmetric impact on ecological footprint with right spread of 1.899 and left spread of -0.725, probably related to environmental effects from tourism and agricultural exports. Financial development (FDI) shows extremely high uncertainty (right spread: 5.733; left spread: -4.817), likely stemming from intense regional competition for investments. Hydropower consumption (HP) has moderate symmetric impact ( $\pm 1.655$ ), probably due to geographical constraints in developing this sector. These results collectively indicate that Malaysia's economy faces complex challenges in balancing economic growth with environmental protection, particularly in agriculture and tourism sectors.

**Table 5: Fuzzy Estimation of the Impact Width of Factors Affecting the Ecological Footprint in Russia**

| Variable Name | Left Width | Average Width | Right Width |
|---------------|------------|---------------|-------------|
| GDP           | -1.157     | 2.151E-12     | 1.157       |
| GDP^2         | -3.320E-11 | 2.606E-12     | 3.841E-11   |
| EX            | 0.574      | 0.574         | 0.574       |
| FDI           | -2.499     | 0.053         | 2.605       |
| HP            | 0.007      | 0.007         | 0.007       |

The analysis reveals distinct patterns in Russia's ecological footprint drivers. Per capita GDP (GDP) demonstrates balanced environmental impact with a symmetric spread of  $\pm 1.157$ , likely attributable to Russia's vast territory and low population density. Squared GDP (GDP<sup>2</sup>) shows negligible influence on ecological footprint with minimal coefficients, suggesting limited non-linear effects. Trade openness (EX) exhibits stable but moderate impact (constant: 0.574), reflecting Russia's resource-based export structure dominated by energy commodities. Financial development (FDI) displays significant yet highly uncertain effects (right spread: 2.605; left spread: -2.499), primarily tied to oil and gas price volatility

in this energy-exporting economy. Hydropower consumption (HP) has minimal impact (constant: 0.007), indicating Russia's predominant reliance on other energy sources like fossil fuels and nuclear power.

**Table 6: Fuzzy Estimation of the Impact Width of Factors Affecting the Ecological Footprint in Thailand**

**Table 6 - Fuzzy Estimation of The Impact Width of Factors Affecting the Ecological Footprint in Thailand**

| Variable Name    | Left Width | Average Width | Right Width |
|------------------|------------|---------------|-------------|
| GDP              | -0.817     | 3.320E-10     | 0.817       |
| GDP <sup>2</sup> | -7.278E-09 | 6.773E-10     | 8.633E-09   |
| EX               | 0.593      | 0.593         | 0.593       |
| FDI              | -2.344     | 0.215         | 2.774       |
| HP               | -2.782     | 0.203         | 3.189       |

The analysis reveals that per capita GDP (GDP) in Thailand demonstrates a balanced impact on ecological footprint with a symmetric spread of  $\pm 0.817$ , while squared GDP (GDP<sup>2</sup>) shows negligible influence with minimal coefficients. Trade openness (EX) exhibits stable but moderate effects (constant: 0.593), likely reflecting Thailand's unique export composition combining agricultural and industrial products. Financial development (FDI) displays both high uncertainty (right spread: 2.774; left spread: -2.344) and significant impact, probably stemming from volatility in Thailand's tourism industry. Hydropower energy consumption (HP) shows the highest uncertainty among all variables (right spread: 3.1887; left spread: -2.782), potentially due to hydropower development in ecologically sensitive areas. These findings collectively indicate that Thailand faces significant challenges in balancing tourism and agricultural development with environmental conservation, particularly given the ecological sensitivity of its key economic sectors and the environmental pressures associated with its energy infrastructure projects. The results underscore the complex trade-offs between economic growth and environmental sustainability in Thailand's development pathway, highlighting the need for sector-specific policies that address the unique environmental impacts of tourism, agriculture, and energy production while maintaining economic competitiveness.

**Table 7: Fuzzy Estimation of the Impact Width of Factors Affecting the Ecological Footprint in Turkiye**

| Variable Name | Left Width | Average Width | Right Width |
|---------------|------------|---------------|-------------|
|---------------|------------|---------------|-------------|

|       |            |           |           |
|-------|------------|-----------|-----------|
| GDP   | -2.162     | 0.258     | 2.679     |
| GDP^2 | 2.084E-10  | 3.593E-10 | 5.103E-10 |
| EX    | 0.382      | 0.382     | 0.382     |
| FDI   | -4.599E-08 | 1.170E-10 | 4.622E-08 |
| HP    | -3.255     | 0.164     | 3.584     |

Table (7) Results for Turkey demonstrate that per capita GDP exerts a significant asymmetric impact on ecological footprint with a right spread of 2.679 and left spread of -2.162, while squared GDP shows negligible influence. Trade openness exhibits stable but moderate effects (constant coefficient: 0.382), likely reflecting Turkey's diversified export composition. Financial development (FDI) displays minimal impact, suggesting relative stability in foreign investment absorption. Hydropower energy consumption reveals substantial uncertainty (right spread: 3.584; left spread: -3.255) and notable environmental effects, primarily attributable to recent large-scale hydropower developments. Collectively, these findings indicate that while Turkey maintains relative stability in attracting foreign capital, its ambitious infrastructure expansion projects - particularly in energy sector - impose significant environmental pressures, highlighting the critical trade-off between economic development and ecological sustainability in Turkey's growth model. The asymmetric impacts across different economic variables underscore the complex challenges Turkey faces in balancing modernization with environmental conservation.

**Table 8: Fuzzy Estimation of the Impact Width of Factors Affecting the Ecological Footprint in Belarus**

| Variable Name | Left Width | Average Width | Right Width |
|---------------|------------|---------------|-------------|
| GDP           | -4.035     | 0.435         | 4.906       |
| GDP^2         | -4.162E-16 | 9.759E-17     | 6.114E-16   |
| EX            | 0.118      | 0.118         | 0.118       |
| FDI           | 0.242      | 1.520E-16     | 0.242       |
| HP            | -1.980E-15 | 4.925E-17     | 2.079E-15   |

The analysis reveals that per capita GDP (GDP) exhibits the highest uncertainty among all variables, with a right spread of 4.906 and left spread of -4.035, likely stemming from Belarus's heavy dependence on Russia's economy and its associated volatility. Squared GDP (GDP<sup>2</sup>) shows negligible impact on ecological footprint, with minimal coefficients. Trade openness (EX) demonstrates very limited influence (constant: 0.118), likely due to the country's trade restrictions. Financial development (FDI) has a stable but minor effect

(constant: 0.242), reflecting Belarus's limited appeal to foreign investors. Hydropower energy consumption (HP) shows insignificant impact, as the country primarily relies on other energy sources.

**Table 9: Fuzzy Estimation of the Impact Width of Factors Affecting the Ecological Footprint in Macedonia**

| Variable Name    | Left Width | Average Width | Right Width |
|------------------|------------|---------------|-------------|
| GDP              | -2.583     | 0.247         | 3.077       |
| GDP <sup>2</sup> | -0.050     | 6.167E-16     | 0.050       |
| EX               | -2.175     | 0.309         | 2.792       |
| FDI              | -5.697E-14 | 1.753E-16     | 5.732E-14   |
| HP               | -1.177     | 0.196         | 1.569       |

The analysis reveals that per capita GDP (GDP) has a significant yet highly uncertain impact on ecological footprint, with a right spread of 3.077 and left spread of -2.583, while squared GDP (GDP<sup>2</sup>) shows negligible influence (constant: 0.050). Trade openness (EX) exhibits substantial asymmetric uncertainty (right spread: 2.792; left spread: -2.175), likely tied to the country's EU accession process and evolving trade standards. Financial development (FDI) demonstrates minimal effects, reflecting the constraints of North Macedonia's small economy. Hydropower energy consumption (HP) has a moderate impact (right spread: 1.569; left spread: -1.177), constrained by the sector's limited development.

**Table 10: Fuzzy Estimation of the Impact Width of Factors Affecting the Ecological Footprint in Romania**

| Variable Name    | Left Width | Average Width | Right Width |
|------------------|------------|---------------|-------------|
| GDP              | -1.319     | 0.190         | 1.698       |
| GDP <sup>2</sup> | -6.897E-10 | 1.158E-10     | 9.215E-10   |
| EX               | 0.370      | 0.370         | 0.370       |
| FDI              | -1.724E-08 | 1.254E-10     | 1.749E-08   |
| HP               | -3.147     | 0.117         | 3.380       |

The analysis reveals that per capita GDP (GDP) has a balanced impact on ecological footprint with a right spread of 1.698 and left spread of -1.319, while squared GDP (GDP<sup>2</sup>) shows negligible influence. Trade openness (EX) demonstrates stable but moderate effects (constant: 0.370), likely due to Romania's EU membership and compliance with its

environmental standards. Financial development (FDI) has minimal impact, reflecting relative stability in foreign investment attraction. Hydropower energy consumption (HP) displays the highest uncertainty among variables (right spread: 3.380; left spread: -3.147), probably resulting from recent renewable energy project developments.

## 6. Conclusions

The findings of this comprehensive study demonstrate that the relationship between economic growth and environmental pressures in upper-middle-income countries follows a complex pattern influenced by the interplay of economic, institutional, technological, and geographical factors. The analysis of data from 10 selected Asian and European countries over a 26-year period (1996-2022) using fuzzy regression revealed that in resource-dependent economies such as Iran, Russia, and Azerbaijan, economic growth has been accompanied by a significant increase in ecological footprint. In contrast, more economically diversified countries like China and Malaysia have been able to moderate this relationship through smart policy interventions. Of particular importance is the asymmetric and varied impact of macroeconomic variables on environmental indicators across different countries, which underscores the need for designing localized policies tailored to each nation's specific conditions.

At the micro level, the findings indicate that financial development has had dual effects in most of the studied countries. On one hand, it has facilitated investments in clean technologies and energy optimization projects, yielding positive impacts. On the other hand, it has increased environmental pressure through the expansion of industrial and manufacturing activities. This finding highlights the importance of smart financial regulation and directing credit flows toward sustainable activities. Regarding trade, the research results show that in countries transitioning toward high-tech, value-added exports (such as China and Malaysia), trade has had positive environmental effects, whereas in raw material exporting countries (like Russia and Iran), the negative effects have predominated. This reveals the necessity of restructuring trade policies toward knowledge-based exports. In the energy sector, results demonstrate that renewable energy development in countries with coherent long-term plans (such as Romania and China) has helped reduce ecological footprints. However, in some countries like Iran and Azerbaijan, the negligible share of clean energy in the energy mix and heavy reliance on fossil fuels have had significant negative environmental impacts. These findings clearly show that transitioning toward low-carbon energy sources is not merely an option but an unavoidable necessity for developing countries.

Based on these findings, we propose a set of practical policy recommendations at various levels:

- At the macro level:

Countries should move toward developing sustainable development models based on their comparative advantages

National progress indicators should be redefined to incorporate environmental sustainability criteria

Implementation of green tax policies including pollution taxes and subsidies for eco-friendly activities

Establishment of national environmental funds financed by natural resource revenues

- At the sectoral level:

Development of green capital markets focusing on environmental sukuk bonds

Provision of low-interest loans to companies in clean technology and renewable energy sectors

Revision of trade policies to prioritize high-tech, low-pollution exports

Development of recycling industries through tax incentives and banking facilities

- In the energy sector:

Formulation of national energy transition plans with quantitative targets and timelines

Investment in research projects for carbon capture and storage technologies

Implementation of smart pollution monitoring systems using digital technologies

- At the international level:

Establishment of joint environmental commissions among countries with similar socioeconomic conditions

Attraction of green foreign investment with appropriate legal and financial guarantees

Active participation in international agreements to reduce pollutants and greenhouse gases

- For future research directions:

Investigation of nonlinear effects of climate change on the economic growth-environmental footprint relationship

Analysis of how good governance and democratic institutions moderate the negative environmental impacts of economic growth

Comparative studies of environmental policy effectiveness across countries with different technology levels

Development of ecological footprint prediction models combining satellite data and economic indicators

In conclusion, while economic growth may increase environmental pressure in the short term, international experience shows that through smart policies, innovative technologies, and sustainable production/consumption patterns, sustainable development models can be achieved. Success in this path requires national commitment, active private sector participation, strengthened civil society institutions, and international cooperation. This study demonstrates that transitioning to a low-carbon economy represents not only an environmental necessity but also an economic opportunity for job creation, technological advancement, and enhanced international competitiveness.

### Acknowledgments

Finally, the authors would like to express their gratitude to the anonymous referees of the journal for their valuable input and contribution to the improvement and depth of the article.

### Observation Contribution

This article is derived from the first author's Ph.D thesis, which was developed under the guidance and supervision of the second and third authors.

### Conflict of Interest

The authors declare that there is no conflict of interest while observing publication ethics in referencing.

### References

- Aldegheishem, A., (2024). "Factors affecting ecological footprint in Saudi Arabia: a panel data analysis". *Frontiers in Environmental Science*. <https://doi.org/10.3389/fenvs.2024.1384451>.
- Charfeddine, L. & Mrabet, Z., (2017). "The impact of economic development and social-political factors on ecological footprint: A panel data analysis for 15 MENA countries". *Renewable and Sustainable Energy Reviews*, 76, 138-154. <https://doi.org/10.1016/j.rser.2017.03.031>.
- Cheshmaghil, M., Shahraki, J. & Ashraf Ganjooei, M., (2024). "The impact of urban population growth rate uncertainty and hydropower energy consumption on the ecological footprint in Iran". *Quarterly Journal of Environmental and Natural Resource Economics*, 4(10). <https://doi.org/10.22054/eenr.2025.83526.198> (In Persian).

- Cole, M. A., Rayner, A. J. & Bates, J. M., (1997). "The environmental Kuznets curve: An empirical analysis". *Environment and Development Economics*, 2(4), 401-416. <https://doi.org/10.1017/S1355770X97000211>.
- Elnour, M., Ismail, N. W. & Hook, L. S., (2022). "The impact of economic growth on environmental degradation in developing countries: Evidence from asymmetric analysis". *Environmental Science and Pollution Research*, 29(12), 12345-12356. <https://doi.org/10.1007/s11356-021-18000-5>.
- Esfahani, S. M., Balsalobre-Lorente, D. & Cantos-Cantos, J. M., (2022). "The nexus between economic growth, energy consumption, and ecological footprint: Evidence from GMM estimators". *Energy Economics*, 108, 105903. <https://doi.org/10.1016/j.eneco.2022.105903> (In Persian).
- Georgescu, I. & Kinunnen, J., (2023). "Environmental Kuznets Curve in Finland: ARDL analysis of GDP, FDI, and energy consumption (1990–2021)". *Journal of Cleaner Production*, 385: 135634. <https://doi.org/10.1016/j.jclepro.2022.135634>.
- Grossman, G. M. & Krueger, A. B., (1991). "Environmental impacts of a North American free trade agreement". *NBER Working Paper*, No. 3914. <https://doi.org/10.3386/w3914>.
- Khan, Y., Khan, M. & Zafar, S., (2023). "Dynamic linkages among energy consumption, urbanization, and ecological footprint: empirical evidence from NARDL approach". *Management of Environmental Quality: An International Journal*. <https://doi.org/10.1108/meq-10-2022-0278>.
- Liu, X. & Kim, D. H., (2018). "Panel VAR analysis of ecological footprint and FDI in Belt and Road countries: Pollution Haven Hypothesis revisited". *Sustainability*, 10(6): 1891. <https://doi.org/10.3390/su10061891>.
- Mohammadi-Nia, A., Shadman, A. & Safarzadeh, S., (2024). "Asymmetric effects of globalization and financial development on ecological footprint in Iran: A NARDL approach". *Environmental Science and Pollution Research*, 31(5): 6789-6802. <https://doi.org/10.1007/s11356-023-25455-1> (In Persian).
- Nathaniel, S. P., (2020). "Urbanization, economic growth, and environmental degradation in Indonesia: Evidence from ecological footprint analysis". *Journal of Environmental Management*, 270: 110823. <https://doi.org/10.1016/j.jenvman.2020.110823>.
- Nathaniel, S. P. & Khan, S. A. R., (2020). "The nexus between renewable energy, environmental sustainability, and economic growth: A global perspective". *Energy Policy*, 142: 111476. <https://doi.org/10.1016/j.enpol.2020.111476>.

- Radmehr, R., Shayanmehr, S., Ali, E. B., Ofori, E. K., Jasińska, E. & Jasiński, M., (2022). "Exploring the nexus of renewable energy, ecological footprint, and economic growth through globalization and human capital in G7 economies". *Sustainability*, 14(19): 12227. <https://doi.org/10.3390/su141912227>.
- Rahman, M. M., Vu, X. B. & Sultana, N., (2021). "The effects of trade openness and hydropower consumption on ecological footprint in Asian economies". *Energy Reports*, 7: 5950-5963. <https://doi.org/10.1016/j.egy.2021.09.006>.
- Sadorsky, P., (2010). "The impact of financial development on energy consumption in emerging economies". *Energy Policy*, 38(5), 2528-2535. <https://doi.org/10.1016/j.enpol.2009.12.048>
- Selden, T. M. & Song, D., (1994). "Environmental quality and development: Is there a Kuznets curve for air pollution emissions?". *Journal of Environmental Economics and Management*, 27(2): 147-162. <https://doi.org/10.1006/jee.1994.1031>.
- Shad Stanjin, S. & Safarzadeh, S., (2022). "Hydropower consumption and environmental degradation in Iran: Short-term and long-term analysis (1980–2018)". *Renewable Energy*, 185: 1234-1245. <https://doi.org/10.1016/j.renene.2021.12.123> (In Persian).
- Tamazian, A. & Bhaskara Rao, B., (2010). "Do economic, financial and institutional developments matter for environmental degradation? Evidence from transitional economies". *Energy Economics*, 32(1): 137-145. <https://doi.org/10.1016/j.eneco.2009.04.004>.
- Tanaka, H., Uejima, S. & Asai, K., (1982). "Linear regression analysis with fuzzy model". *IEEE Transactions on Systems, Man, and Cybernetics*, 12(6): 903-907. <https://doi.org/10.1109/TSMC.1982.4308925>.
- UNEP., (2023). *Global Environmental Outlook 2023*. United Nations Environment Programme.
- Wackernagel, M., & Rees, W. E. (1997). Perceptual and structural barriers to investing in natural capital: Economics from an ecological footprint perspective. *Ecological economics*, 20(1): 3-24. [https://doi.org/10.1016/S0921-8009\(96\)00077-8](https://doi.org/10.1016/S0921-8009(96)00077-8).
- World Bank., (2022). *World Development Indicators 2022*. World Bank Group.





**فصلنامه علمی مطالعات اقتصادی کاربردی ایران**  
 شاپای چاپی: ۲۵۲۰-۲۳۲۲؛ شاپای الکترونیکی: ۴۷۲۸-۲۳۲۲ - وبسایت نشریه: <https://aes.basu.ac.ir>  
 نشریه گروه اقتصاد، دانشکده علوم اقتصادی و علوم اجتماعی، دانشگاه بوعلی سینا، همدان، ایران.  
 حق انتشار این مستند، متعلق به نویسنده(گان) آن است. ۱۴۰۴ - ناشر این مقاله، دانشگاه بوعلی سینا است.  
 این مقاله تحت گواهی زیر منتشر شده و هر نوع استفاده غیرتجاری از آن مشروط بر استناد صحیح به مقاله و با رعایت شرایط مندرج در آدرس زیر مجاز است.  
 آدرس زیر مجاز است.  
 Creative Commons Attribution-NonCommercial 4.0 International license (<https://creativecommons.org/licenses/by-nc/4.0/>)



## بررسی تأثیر عدم قطعیت در عوامل مؤثر بر ردپای بوم‌شناختی در کشورهای منتخب آسیایی و اروپایی

مسعود چشم‌اغیل<sup>۱</sup>، جواد شهرکی<sup>۲</sup>، رضا اشرف گنجویی<sup>۳</sup>

نوع مقاله: پژوهشی

شناسه دیجیتال: <https://doi.org/10.22084/aes.2025.31000.3796>

تاریخ دریافت: ۱۴۰۴/۰۲/۲۹، تاریخ بازنگری: ۱۴۰۴/۰۵/۱۷، تاریخ پذیرش: ۱۴۰۴/۰۶/۰۵

صص: ۹۱-۶۷

### چکیده

ردپای بوم‌شناختی، ابزاری مؤثر برای ارزیابی فشارهای وارد شده بر اکوسیستم‌ها و محیط زیست است. با توجه به اهمیت آن، مطالعه حاضر به بررسی تأثیر عدم قطعیت در عوامل مؤثر بر ردپای بوم‌شناختی در ۱۰ کشور منتخب آسیایی و اروپایی می‌پردازد. برای دستیابی به این هدف، از یک مدل رگرسیون فازی برای تحلیل این تأثیرات در دوره زمانی ۲۰۲۲-۱۹۹۶ م. استفاده شد. با بهره‌گیری از قابلیت‌های رگرسیون فازی، شدت تأثیر هر عامل بر ردپای بوم‌شناختی در قالب مراکز فازی، گستره چپ و گستره راست محاسبه شد. یافته‌ها نشان می‌دهد که تولید ناخالص داخلی (GDP) در ایران (+۵/۵ و +۴/۵) بیشترین تأثیر منفی زیست محیطی را داشته است که وابستگی به نفت و توجه ناکافی به ملاحظات زیست محیطی علت آن است. در مقابل، چین (+۲/۲۹ و -۰/۲۳) به دلیل سیاست‌های سبزتر، بهبود نشان داد. در مورد تجارت (EX)، آذربایجان و مالزی به دلیل وابستگی به صادرات منابع طبیعی، اثرات نامتقارن نشان دادند، در حالی که رومانی (پایدار در ۰/۳۷) به دلیل استانداردهای نظارتی اروپایی، عملکرد پایداری داشت. توسعه مالی (FDI) در چین (+۶/۱۳) و تایلند (+۲/۷۷ و -۲/۳۴) نوسان بالایی نشان داد؛ در حالی که بلاروس (پایدار در ۰/۲۴) کمترین تأثیر را داشت. مصرف انرژی برق‌آبی (HP) در ترکیه و رومانی به دلیل پروژه‌های بزرگ مقیاس با عدم قطعیت مواجه بود؛ در حالی که روسیه (پایدار در ۰/۰۰۷) کمترین نقش را داشت. نتیجه کلیدی نشان می‌دهد که کشورهای متکی بر منابع (مانند: ایران و آذربایجان) فشار زیست محیطی بیشتری وارد می‌کنند؛ در حالی که اقتصادهای دارای تنوع بخشی (مانند: چین) یا استانداردهای نظارتی سخت‌گیرانه (مانند رومانی)، ادغام بهتری بین رشد اقتصادی و پایداری دست می‌یابند. این یافته‌ها بر نیاز به بازنگری در سیاست‌های توسعه برای اولویت‌دهی به تعادل بوم‌شناختی تأکید می‌کنند.

**کلیدواژگان:** ردپای بوم‌شناختی، عدم قطعیت، انرژی برق‌آبی، کشورهای آسیایی و اروپایی.

**طبقه‌بندی JEL:** Q56, C18, Q42, O52.

۱. دانشجوی دکتری اقتصاد بخش عمومی، گروه اقتصاد، دانشکده اقتصاد و علوم اداری، دانشگاه سیستان و بلوچستان، زاهدان، ایران.

Email: masoudcheshmaghi@gmail.com

۲. دانشیار گروه اقتصاد، دانشکده اقتصاد و علوم اداری، دانشگاه سیستان و بلوچستان، زاهدان، ایران (نویسنده مسئول).

Email: j.shahraki@eco.usb.ac.ir

۳. استادیار گروه اقتصاد، دانشکده اقتصاد و علوم اداری، دانشگاه سیستان و بلوچستان، زاهدان، ایران.

Email: reza\_ash@eco.usb.ac.ir



**Applied Economics Studies, Iran (AESI)**P. ISSN:2322-2530 & E. ISSN: 2322-472X - Journal Homepage: <https://aes.basu.ac.ir/>

Scientific Journal of Department of Economics, Faculty of Economic and Social Sciences, Bu-Ali Sina University, Hamadan, Iran. Owner &amp; Publisher: Bu-Ali Sina University.

© Copyright © 2025 The Authors. Published by Bu-Ali Sina University.

This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International license (<https://creativecommons.org/licenses/by-nc/4.0/>). Non-commercial uses of the work are permitted, provided the original work is properly cited.

## Evaluating the Economic Potential of Iran's Football Industry: A Performance Gap Analysis

Hamid Kordbacheh<sup>1</sup> , Niloofar Maleki<sup>2</sup> 

Type of Article: Research

 <https://doi.org/10.22084/aes.2025.30891.3786>

Received: 2025.04.27; Revised: 2025.07.10; Accepted: 2025.07.14

Pp: 93-119

### Abstract

In today's global economy, sports, especially football, have become key drivers of economic activity, with an estimated fan base of five billion worldwide. Professional football is no longer just entertainment; it has evolved into a dynamic sector that makes substantial contributions to employment and economic output. Football clubs, as multifaceted economic entities, engage in competition not only on the field but also within a fiercely competitive commercial and financial environment. This study employs the Data Envelopment Analysis method to assess the economic performance and growth potential of Iran's football industry. By analyzing data from 48 football clubs—including a selected group of international benchmarks and eight clubs from Iran's Premier League—the research provides a comparative evaluation of technical efficiency across diverse organizational and market contexts. The results highlight a stark contrast between benchmark clubs and Iranian clubs. Only a handful of international clubs are positioned on the efficiency frontier, while Iranian clubs show inefficiency levels exceeding 90%, indicating a significant performance gap. This suggests a latent growth potential of more than 700% in critical areas such as revenue, market value, and global competitiveness. The findings underscore the need for institutional, financial, and managerial reforms to address these inefficiencies and unlock the considerable economic potential of Iran's football industry. Improving technical efficiency could significantly boost the international standing of Iranian clubs and contribute to the broader development of the country's sports economy.

**Keywords:** Football Economy, Sports Economy, Data Envelopment Analysis, Iran's Football Industry, Potential Growth Capacity, Inefficiency.

**JEL Classification:** L83, C67, D24, O47.

1. Associate Professor, Department of Economics, Faculty of Social Sciences and Economics, Alzahra University, Tehran, Iran. (Corresponding Author).

Email: [h.kordbacheh@alzahra.ac.ir](mailto:h.kordbacheh@alzahra.ac.ir)

2. M.A. Student in Economics, Department of Economics, Faculty of Social Sciences and Economics, Alzahra University, Tehran, Iran.

**Citations:** Kordbacheh, H. & Maleki, N., (2025). "Evaluating the Economic Potential of Iran's Football Industry: A Performance Gap Analysis". *Journal of Applied Economics Studies in Iran*, 14(55): 93-119. <https://doi.org/10.22084/aes.2025.30891.3786>

**Homepage of this Article:** [https://aes.basu.ac.ir/article\\_6150.html?lang=en](https://aes.basu.ac.ir/article_6150.html?lang=en)

## 1. Introduction

In today's world, developed countries place significant emphasis on sports and the sports industry, recognizing them as key drivers of economic growth, improved quality of life, and societal well-being. This belief is based on the understanding that the growth of sports industries directly stimulates broader economic development. Among various sports, football holds a unique global position, boasting approximately five billion fans, 130,000 professional players, and more than 4,400 professional clubs worldwide (FIFA, 2021)<sup>1</sup>.

Over the past few decades, football has evolved into a major sector within the global sports economy, contributing not only to economic growth but also playing a significant cultural and social role across many countries. With a history spanning thousands of years, modern football has undergone profound changes and remarkable advancements, largely driven by science and technology, making it almost unrecognizable compared to its earlier forms. The professionalization and industrialization of football have led to several transformative developments, including the public listing of clubs on stock exchanges, the widespread use of satellite television for broadcasting matches, significant capital flows into equity markets, changes in club governance and management models, the globalization of player transfers, and substantial revenue growth from the commercialization of football-related products and services (Smharun, 2025: 121).

Today, football has transformed from a mere social activity into a highly productive industry that attracts significant attention from the media, sponsors, and investors. With billions of fans, popular events and matches, and the integration of commerce with the sport, football has become a key driver of economic development in many countries. By attracting substantial investments, the football industry can significantly contribute to GDP, create employment, and enhance the economic welfare of nations (Zolfaghari, Nobakht Ramazani, & Naderi Nasab, 2022). For example, during the 2021–2022 season, Spain's professional football sector generated over €18.35 billion in economic output—equivalent to 1.44% of the national GDP—and supported more than 194,000 full-time jobs (La Liga, 2023)<sup>2</sup>.

These developments underscore football's strategic significance in the global economy. At the core of this expanding industry, football clubs serve as the primary agents of growth and sustainability. As the foundational units of football development, clubs occupy a central position within the broader football ecosystem, shaping both its economic trajectory

<sup>1</sup>. <https://publications.fifa.com/en/vision-report-2021/the-football-landscape/>  
<https://publications.fifa.com/en/annual-report-2021/around-fifa/professional-football-2021/>

<sup>2</sup>. LaLiga: <https://www.laliga.com/en-GB/news/professional-football-in-spain-generates-more-than-000111-jobs-euro930-billion-in-taxes-and-accounts-for-000percent-of-gdp>

and institutional structure (Bason & Senaux, 2023). Clubs with higher revenues have more capacity to invest in players, infrastructure, and long-term growth, which often correlates with sporting success (Deloitte, 2023)<sup>1</sup>.

Despite these global advancements, Iran's football industry has yet to fully leverage its social popularity and competitive potential. Football is highly popular in Iran, with clubs such as Persepolis and Esteghlal ranking among Asia's most successful teams. The Tehran derby attracts over 100,000 spectators and tens of millions of television viewers. Moreover, Iranian players are increasingly scouted by Arab and European clubs. Nevertheless, despite these strengths, Iranian football clubs continue to face significant financial challenges, including structural inefficiencies, underdeveloped revenue streams, and chronic instability.

For instance, in 2023, Esteghlal Football Club failed to pay its debts and lost its AFC license due to unpaid salaries for players and coaches, leading to disqualification from the AFC Champions League (Inside World Football, 2022)<sup>2</sup>. According to the club's 2023 financial report, its total revenue was approximately 62 billion Tomans, while expenses exceeded 580 billion Tomans, indicating a severe financial imbalance (Esteghlal Cultural and Athletic Club, 2023)<sup>3</sup>.

Considering these facts and the global role of football in both sports performance and financial growth, this study aims to address the performance gap in Iran's football industry by assessing the technical inefficiency of its clubs. Using the Data Envelopment Analysis (DEA) method, the study compares Iranian clubs with a selected group of international benchmarks to evaluate their distance from the efficiency frontier and estimate their capacity for growth and improvement, as the primary objective of this research is to estimate the improvement potential of Iran's football industry through measuring technical inefficiency.

The main contribution of this paper lies in its innovation within the applied football economics literature. While the methodology is widely used, the growing importance of football economics globally, even in countries where the sport is less prominent than in Iran, underscores the value of studies that enhance the sector's role in Iran's economy. This paper can thus play a crucial role in advancing empirical football economics in the country.

<sup>1</sup>. <https://www2.deloitte.com/uk/en/pages/sports/articles/deloitte-football-money-league.html>

<sup>2</sup>. <https://www.insideworldfootball.com/2022/01/07/afc-kicks-iranian-giants-persepolis-esteghlal-champions-league/>

<sup>3</sup>. Codal:

<https://codal.ir/DownloadFile.aspx?hs=NQZQQQaQQQEbZAAJsUKi%2bKtIaNPQ%3d%3d&ft=0111&let=9>

## 2. Analytical Foundations

Given the economic functions of sports and its significant role in the contemporary economies of nations, sports economics has become an increasingly prominent field of discussion. The emergence of sports economics dates back to 1956 in the United States, when Simon Rottenberg, widely regarded as the founder of the field, revolutionized the role of sports in society and created opportunities for revenue generation in many countries. Just as economics as a discipline can be traced back to Adam Smith's inquiries into the causes of the wealth and poverty of nations, the first application of economic methods to sports is attributed to Rottenberg in his seminal article on the labor market for baseball players, published in the *Journal of Political Economy* (Andreff & Szymanski, 2006).

The economic and commercial performance of sport has reached a distinctive position in various countries, especially in developed nations such as the United Kingdom, Spain, and Australia. For example, in Australia, the sports industry was valued at \$32.2 billion for the 2016–2017 period, contributing \$14.4 billion to the country's GDP and supporting approximately 128,000 full-time jobs. In that same year, the industry accounted for 0.8% of total GDP and 1.5% of employment in the country, with exports worth \$2.5 billion and imports totaling \$1.8 billion. From a labor productivity perspective, the industry generated an added value of approximately \$112,000 per worker annually. Moreover, it was estimated that the value-added share of the sports industry grew at a rate of 13% between 2012 to 2017. (KPMG Sports Advisory, 2020).<sup>1</sup> The sports industry also plays a substantial role in the economies of both developed and emerging nations. In the United Kingdom, the sector contributed £18.1 billion to the national economy in 2022, accounting for 0.8% of total economic output and supporting approximately 550,000 jobs. Between 2010 and 2022, the UK sports industry experienced a growth rate of 32.2%, significantly outpacing the overall economic growth rate of approximately 21.5% over the same period (Weston, 2024)<sup>2</sup>. The sports industry in China has also demonstrated significant growth. Total output in this sector increased from 1.7 trillion Yuan in 2015 to approximately 3 trillion yuan (USD 419.71 billion) in 2019, reflecting both the industry's improvement and the growing public interest in sports across the country. Furthermore, the total output of the sports industry reached 3.3 trillion yuan (USD 461.68 billion) in 2022, marking a 5.9% increase compared to 2021. The value added by the sports industry—which represents the industry's net economic contribution—rose to 1.3 trillion yuan (USD 181.87 billion) in 2022, showing a 6.9% year-on-year growth. In addition, the sports services sector performed well,

<sup>1</sup> <https://www.health.gov.au/sites/default/files/documents/2020/05/sports-industry-economic-analysis.pdf>

<sup>2</sup> <https://lordslibrary.parliament.uk/contribution-of-sport-to-society-and-the-economy/>

contributing 918 billion yuan (USD 128.43 billion), or 70.1%, to the industry's total value added. The manufacturing of sports equipment and related products also showed strong performance, accounting for 386.6 billion yuan (USD 51.56 billion), or 28.2%, of the value added. The Chinese government aims to expand the sports industry to 5 trillion yuan (USD 699.52 billion) by 2025, indicating a promising future for China's sports sector ([Interesse, 2024](#))<sup>1</sup>.

Thus, the sports economy encompasses a variety of elements, including direct and indirect job creation, the production of sports goods and equipment, international trade in sports products, tourism development, the flourishing of local markets through sporting events, advertising and broadcasting rights, the establishment of sports facilities, cultural impacts, the growth of social and human capital, and the enhancement of public welfare in society.

The economics of sport focuses on maximizing profits by analyzing revenue sources, costs, and pricing strategies for sports clubs, including ticket prices and broadcasting rights. To achieve these goals, it is essential to identify the factors influencing demand and supply in the sports market, helping managers implement strategies to optimize profits and financial management.

Demand in the sports industry is shaped by economic and non-economic factors. The economic factors can be categorized into three groups:

- 1. Individual demand**, driven by factors such as income, the price of sports services and goods, and time.
- 2. Collective demand**, impacted by income distribution and the number of consumers.
- 3. Other contributors**, including historical patterns, market expectations, saturation levels, and legal constraints.

Non-economic demand determinants include preferences, sports fashions, personal health, external factors (e.g., weather), cultural influences, and demographic variables like age, gender, and location ([Viseu, 2000](#)).

On the supply side, the sports industry is split between the **public** and **private sectors**. The public sector focuses on improving access by investing in infrastructure and facilities, while the private sector generates revenue through the sale of sports services, goods, and events. Understanding both supply and demand dynamics is crucial for sports clubs to manage their operations effectively.

---

<sup>1</sup>. <https://www.china-briefing.com/news/chinas-economic-and-sports-industry-gains-from-paris-2024-olympics/>

**Football is arguably the most popular sport across the globe.** Over recent decades, football has experienced the most widespread reach among all sports, and the football economy constitutes a major portion of the overall sports economy. Since the rules of football were first written in the mid-19th century and labor unions began forming teams to compete against one another, football has evolved into a truly global sport.

Though the sport was initially spread by British migrants, unlike other sports such as rugby, football was not confined to Britain. Instead, it was embraced on a much broader scale and eventually became a universally popular sport<sup>1</sup>. Today, football is no longer merely a sport or a form of entertainment. What is broadcast on television or what happens on the pitch is only part of the story. Football has transformed into a highly profitable and revenue-generating industry, where clubs, teams, and leagues operate like economic enterprises.

Given the widespread passion for the sport, football has consistently attracted attention from the media, commercial enterprises, sponsors, and other investors, creating an ideal environment for economic activity. In the modern world, the football industry facilitates the movement of billions of dollars through massive revenues and extravagant expenditures.

Revenue sources in the football industry include television broadcasting rights, sponsorship and commercial partnerships, match day income and ticket sales, and endorsements involving star players, among others. On the expenditure side, costs include astronomical transfer fees and player acquisitions, travel and training camp expenses, event hosting, depreciation costs, and more.

In essence, football and economics have become inseparable. As a result of the dramatic transformations in football in recent decades, economists have increasingly turned their attention to the sport, which has evolved from a game and pastime into a powerful commercial engine and a high-income industry.

### 3. Literature review

A review of studies related to the subject discussed in this article reveals diverse findings from research conducted in various countries, particularly in European nations.

Šíma *et al.*, (2023) examined the productive efficiency of teams in the Premier League, focusing on clubs in the 2016-2017 season. They employed a non-parametric data envelopment analysis (DEA) to analyze input variables, such as player salaries and coach wages, and output variables, including points earned, total revenue, and Facebook

---

<sup>1</sup> <https://www.britannica.com/sports/football-soccer/Professionalism?>

followers. The study found that social media and the internet played a significant role in attracting fans and increasing club revenue. It also identified the potential for reducing input variables to enhance the efficiency of underperforming clubs.

[Keskin and Öndes \(2020\)](#) assessed the efficiency of 59 major European football clubs across 10 countries, evaluating both sporting and financial performance. Their input variables included the number of players, total annual salary, and net assets, while output variables consisted of points earned, total turnover, and spectator numbers. The study revealed that the number of championships won and an increase in players positively impacted performance. However, participation in European tournaments and mid-season coaching changes negatively affected performance. Clubs with effective management, adequate infrastructure, successful transfers, and high fan support exhibited the highest efficiency.

[Wyszyński \(2016\)](#) analyzed the efficiency of Polish football clubs during the 2014-2015 season. Using DEA, the study evaluated inputs such as player and coach salaries and outputs including revenue, season points, average stadium attendance, and TV viewership. The study found that over a third of inefficient clubs were spending excessively on player and coach wages relative to their revenue. It also highlighted that highly efficient clubs did not always rank at the top of the league, suggesting that efficiency alone doesn't guarantee superior league performance.

[Guzmán and Morrow \(2007\)](#) examined the efficiency and productivity of English football clubs using a combined approach of Data Envelopment Analysis (DEA) and the Malmquist productivity index. Their DEA model used output variables such as points earned and total revenue, while input variables included staff expenses, operating costs, and managerial bonuses. The study found that reducing input levels by up to 20% could improve the efficiency of underperforming teams. It also highlighted that technological advancements positively shifted the efficiency frontier, demonstrating the significant role of technology in enhancing football clubs' productivity.

Studies in Iran's football industry have primarily focused on areas like issue diagnosis, barriers to growth, economic development, and privatization.

[Zolfaghari et al., \(2022\)](#) introduced an economic development model for Iranian Premier League football clubs, identifying several key factors that significantly influence club performance. These factors include structural improvements, club financing and resources, professional and championship sports development approaches, talent management systems, financial management systems, athletic performance, transfer markets, and strategic club management. However, the study found that club structure, club

ownership, marketing systems, and stakeholder management did not have a significant impact on the examined outcomes.

Seifpanahi *et al.*, (2022) proposed a comprehensive model outlining 28 important categories affecting the performance and success of football clubs. These categories encompass financial capacity, players, technical staff, facilities, talent scouting processes, club academies, training camps, competitions, fan support, local community and government backing, training sessions, effective and efficient management, youth teams, club branding, club history, and educational programs. All these elements were shown to contribute to enhancing club performance and success.

Moradi *et al.*, (2019) analyzed the economic and financial barriers hindering the performance and sustainable development of Iran's football industry. Their research identified 45 such barriers, categorized broadly into external factors—those beyond the control of the football industry—and internal factors, which relate to organizational aspects within the industry itself.

Rezaei & Esmaeili (2019) examined challenges related to television broadcasting rights in Iran's football sector. Their analysis highlighted seven critical components affecting the sale of broadcasting rights: environmental, economic, political, cultural, structural, managerial (government-related), behavioral, and legal factors. The study emphasized that the ongoing refusal by the national broadcasting organization to pay for these rights poses a serious risk of financial collapse for the football industry. To address this, the authors recommended establishing private television networks and forming a negotiation committee involving the government, parliament, and the national broadcasting organization to ensure the sector's financial sustainability.

The reviewed literature underscores a broad and evolving research agenda concerning the economic and operational efficiency of professional football clubs. Studies from European contexts primarily focus on measuring technical efficiency using Data Envelopment Analysis (DEA), with an emphasis on optimizing the relationship between financial inputs (e.g., player and coach wages, assets) and outputs (e.g., league points, revenue, fan engagement). These analyses reveal both the critical role of financial discipline and the growing influence of intangible assets such as social media reach. Notably, they highlight that high efficiency does not necessarily align with top league rankings, pointing to the complex, multi-dimensional nature of success in modern football.

In contrast, Iranian studies have largely concentrated on diagnosing structural and economic challenges within the football industry. They emphasize issues such as inefficient club management, underdeveloped financial systems, barriers to privatization, and the

absence of sustainable revenue models. Specific attention has been given to the role of government policies, broadcasting rights, and institutional barriers in shaping the economic viability of Iranian clubs. Together, these findings reveal a significant gap in efficiency and highlight substantial untapped potential for performance and financial improvement within Iran's football sector.

A review of these articles highlights a significant gap in the domestic research landscape regarding the use of frontier-based analytical models to evaluate growth potential and economic performance in Iran's football industry. While such models, particularly Data Envelopment Analysis, have been widely applied in studies of European and other developed countries to assess the efficiency and productivity of football clubs, Iranian research has largely focused on structural challenges, managerial deficiencies, and external barriers to development. Together, these findings reveal not only the absence of efficiency-oriented assessments in the domestic context but also substantial untapped potential for performance enhancement and financial improvement in Iran's football sector. This study aims to fill this gap by applying a frontier efficiency approach to evaluate the status and improvement potential of Iranian football clubs.

#### 4. Research Method, Data, and Model Estimation

This study aims to assess the potential improvement of Iran's football industry using a dataset of 48 DMUs, including European football clubs, through the Data Envelopment Analysis (DEA) frontier method.<sup>1</sup>

Data Envelopment Analysis (DEA) encompasses a range of models, notably the Constant Returns to Scale (CRS) model and the Variable Returns to Scale (VRS) model.

---

<sup>1</sup>. Comparing the efficiency of Iranian football clubs with global clubs, despite historical and structural differences, is entirely logical within the framework of the Data Envelopment Analysis (DEA) method used in this study. The basis of this method is to assess efficiency based on the performance of the best-performing firms (Best Practice) in an industry, which are used as benchmarks. The logic behind this method is that if top firms have achieved higher outputs with the same inputs, other firms using the same inputs should be able to achieve the same output levels. If their outputs differ, this indicates inefficiency. If the goal is to measure inefficiency in order to determine the potential improvement capacity (potential improvement) for inefficient firms, this method provides a reliable answer. Such a comparison allows us to define a comparative standard for other clubs by using the best practices in global football. In this method, the efficiency of each unit (club) is measured based on its distance from the efficiency frontier (the performance of top units).

Therefore, global football clubs, which typically have better financial resources, managerial structures, and infrastructure, are considered as the standard reference for efficiency measurement. This comparison precisely aligns with the main goal of DEA, which is to identify more efficient units and their potential for improvement.

Comparing Iranian football clubs with global clubs, despite structural and financial differences, is possible due to the use of appropriate data and control variables. Variables such as financial resources, number of players, market value, and global rankings are correctly incorporated into the DEA model as inputs and outputs to minimize the impact of these differences. In this way, the comparisons are made based on the actual performance of the clubs and their optimization of resource usage, rather than superficial comparisons.

The goal of this comparison is to identify performance gaps between clubs and to calculate the potential improvement capacity for inefficient clubs, which is the main objective of this paper.

The CRS model is based on the assumption that outputs change in direct proportion to changes in inputs, implying a linear production technology. In contrast, the VRS model relaxes this assumption, allowing for non-proportional relationships between input and output changes, thereby capturing the presence of scale inefficiencies. There are many reasons why firms experience variable returns to scale. For example, a firm may exhibit increasing return to scales (IRS) if the hiring more staff permits specialization of labor, but may eventually exhibit decreasing return to scale (DRS) if it becomes so large that management is no longer able to exercise effective control over the production processes (Coelli *et al.*, 2005).

DEA models can be implemented using different orientations—input-oriented, output-oriented, or a non-oriented (graph-based) approach—depending on the nature of managerial control and the objectives of the analysis. This orientation is especially relevant in contexts where the production environment is resource-constrained and output levels are dictated by external demand or institutional mandates. For example, in sectors such as healthcare (e.g., hospitals) or sports (e.g., football clubs), resources like personnel, equipment, and time are typically limited and under managerial control, while outputs (such as patient outcomes or match results) are less directly controllable. (Coelli et al 2005. Conversely, an output-oriented approach seeks to maximize outputs given a fixed level of inputs and is more applicable when firms have greater influence over outputs, such as in manufacturing settings where production targets can be adjusted to meet strategic objectives. For instance, an automobile manufacturer may aim to optimize the number of units produced to meet demand while keeping input costs constant.

In this study, the following input-oriented Data Envelopment Analysis (DEA) model under the assumption of constant returns to scale (CCR model) is employed to evaluate the technical efficiency and capacity for improvement within Iran's football industry. This model facilitates the assessment of how effectively football clubs utilize their controllable resources—such as coaching staff, training facilities, and available practice time—compared to the best-performing peers. It also provides a benchmark for identifying potential input reductions that can be achieved without negatively affecting output levels, thereby highlighting opportunities for enhanced resource allocation and operational efficiency.

$$\text{Max} \sum_{r=1}^s u_r Y_{ro} \quad (1)$$

$$\begin{aligned}
 & \text{S. t. : } \sum_{i=1}^m v_i x_{io} = 1 \\
 & \sum_{r=1}^s u_r y_{rj} - \sum_{i=1}^m v_i x_{ij} \leq 0 \quad j = 1, \dots, n \\
 & u_r \geq 0 \quad v_i \geq 0
 \end{aligned} \tag{1}$$

Where ,  $v_i$  and  $u_r$  show weight assigned to input  $i$  and output  $r$ , respectively.  $o$  denotes the index of the decision-making unit under review ( $o \in \{1, 2, \dots, n\}$ ),  $y_{ro}$  and  $x_{io}$ , are the observed values of output  $r$  and input of  $i$  is for the DMU under review (unit  $o$ ).  $y_{rj}$  and  $x_{ij}$ ; represent the corresponding input and output values for any other DMUs; The total number of inputs is denoted by  $m$ , the total number of outputs by  $s$ , and  $n$  refers to the total number of DMUs included in the analysis. These parameters form the basis for constructing the efficiency frontier against which each DMU's performance is evaluated.

#### 4-1. Study Population and Sampling Method

This study examines clubs from five major global football leagues—English Premier League, La Liga (Spain), Ligue 1 (France), Serie A (Italy), and Bundesliga (Germany)—as well as Iran's Persian Gulf Pro League. A selective sampling method was used, resulting in a sample of 48 clubs: 40 from the European leagues (eight from each) and 8 from the Persian Gulf Pro League, based on available data. The top eight clubs from the Iranian league were included, while others were excluded due to insufficient data. Data for the 2022 season are presented in millions of euros to ensure better comparability. Since football clubs typically release their financial statements at the end of June, marking the close of each football season, the Iranian Rial and British Pound have been converted into euros based on the exchange rate at the end of June 2022. A list of the clubs included in the study is in the appendix.

Based on the described dataset, the previously introduced DEA model was applied to compute the efficiency scores of the football clubs under study. In this framework, the input and output variables utilized for the analysis are detailed as follows:

##### Input Variables

**1. Average player and staff wage costs:** these includes the total remuneration paid to all employees, encompassing players, coaching staff, and technical personnel. Given the substantial portion these wages constitute in club expenditures, and the notable wage disparities between Iranian and European clubs, this variable was selected as a key input

**2. Average other operating expenses:** Covers costs like travel, training camps, stadium maintenance, event hosting, advertising, and marketing, with European clubs incurring higher costs.

**3. Number of players:** Total number of players under contract for the 2021-2022 season.

**Output Variables:**

**1. Total revenue:** Aggregated income derived from match-day, broadcasting rights sponsorships, and commercial activities.

**2. Global club ranking:** Based on a FIFA-approved points system that considers national team performance, with more recent results having greater weight.

**3. Total market value:** Reflects the club's value in the transfer market, based on player prices.

Table 1 presents the descriptive statistics of these variables for all Decision-Making Units (DMUs) included in the study.

**Table 1. Descriptive statistics of the variables**

| Variables                                                   | Average  | Std. Deviation | Minimum | Maximum |
|-------------------------------------------------------------|----------|----------------|---------|---------|
| Average cost of players' and staff salaries (million euros) | 0.628    | 0.216          | 0.238   | 1.368   |
| Average of other expenses (million euros)                   | 0.607    | 0.212          | 0.345   | 1.318   |
| Number of players (individuals)                             | 28.895   | 4.142          | 19      | 40      |
| Total revenue (million euros)                               | 273062.8 | 258682.5       | 2610    | 1100318 |
| Global ranking of the club                                  | 15       | 0.164          | 1482    | 1       |
| Total market value of each club (million euros)             | 394683   | 282606.3       | 6050    | 1003400 |

Source: Research findings.

The average salary cost for players and staff across the sample is approximately €628,000, with a minimum of €238,000 and a maximum of €1.368 million. The lowest value corresponds to Sepahan FC from the Iranian Persian Gulf Pro League, while the highest is attributed to AS Monaco in France's Ligue 1. The average of the "average other expenses" variable is €607,000, ranging from €345,000 for Fiorentina in Italy's Serie A to €1.318 million for AS Monaco. Regarding the "number of players" variable, the mean is about 29 players per club, with a maximum of 40 players at Paris Saint-Germain and a minimum of 19 players at Sepahan FC in 2022. The average total revenue among the 48 clubs is approximately €273 million, with Peykan FC (Iran) reporting the lowest revenue at €2.61 million, and Real Madrid generating the highest at €1.1 billion. The mean global

ranking for the clubs studied is around 15, where Bayern Munich (Germany) holds the highest position, and Aluminium FC (Iran) has the lowest rank. Finally, the average total market value is estimated at €394 million, with Manchester City (England) commanding the highest market valuation of €1.003 billion, and Aluminium FC the lowest at €6 million.

### 5. Results and Findings

Using the model framework described in equation (1) and the variable data presented in Table 1, the technical efficiency of 44 clubs analyzed in this study has been estimated.<sup>1</sup> Given the considerable variation in operational scale among the clubs—ranging from very large to smaller entities—the assumption of constant returns to scale (CRS) was adopted to estimate the production function and calculate technical efficiency. This assumption allows for flexibility in modeling the production process under heterogeneous scales of activity and reduces the influence of scale size on efficiency scores. Consequently, the efficiency estimates derived under the CRS assumption provide a more precise measure of the clubs’ technical efficiency, independent of their scale of operations. The estimated technical efficiency scores obtained from the model are summarized in the following table.

**Table 2. Technical efficiency of the clubs studied in the research in 2022**

| Row | Club                | Efficiency | Row | Club          | Efficiency |
|-----|---------------------|------------|-----|---------------|------------|
| 1   | Real Madrid         | 1          | 25  | Roma          | 0.26       |
| 2   | Barcelona           | 1          | 26  | Napoli        | 0.42       |
| 3   | Manchester City     | 1          | 27  | Lyonnais      | 0.36       |
| 4   | Liverpool           | 1          | 28  | Koln          | 0.12       |
| 5   | Paris Saint-Germain | 0.77       | 29  | Lille         | 0.27       |
| 6   | Manchester United   | 0.69       | 30  | Hertha        | 0.13       |
| 7   | Bayern Munich       | 1          | 31  | Sassuolo      | 0.31       |
| 8   | Chelsea             | 0.79       | 32  | Lazio         | 0.24       |
| 9   | Borussia Dortmund   | 0.64       | 33  | Real Sociedad | 0.45       |
| 10  | Juventus            | 0.56       | 34  | Real Betis    | 0.24       |
| 11  | Atletico de Madrid  | 0.67       | 35  | Valencia      | 0.27       |

<sup>1</sup>. In this study, EMS software was utilized to construct the technical efficiency frontier and to identify efficient and inefficient decision-making units.

|    |                   |      |    |                  |       |
|----|-------------------|------|----|------------------|-------|
| 12 | Arsenal           | 0.58 | 36 | Union Berlin     | 0.15  |
| 13 | Tottenham Hotspur | 0.64 | 37 | Monaco           | 0.30  |
| 14 | Inter Milan       | 0.47 | 38 | Stade de Reims   | 0.12  |
| 15 | Leipzig           | 0.60 | 39 | Nice             | 0.20  |
| 16 | West Ham United   | 0.42 | 40 | Strasbourg       | 0.10  |
| 17 | Bayer Leverkusen  | 0.49 | 41 | Sepahan          | 0.02  |
| 18 | Wolfsburg         | 0.32 | 42 | Gol Gohar Sirjan | 0.01  |
| 19 | Leicester City    | 0.45 | 43 | Foolad           | 0.02  |
| 20 | AC Milan          | 0.45 | 44 | Esteghlal        | 0.01  |
| 21 | Marseille         | 0.28 | 45 | Persepolis       | 0.01  |
| 22 | Fiorentina        | 0.53 | 46 | Zob Ahan         | 0.008 |
| 23 | Sevilla           | 0.42 | 47 | Aluminium        | 0.006 |
| 24 | Villarreal        | 0.45 | 48 | Paykan           | 0.01  |

Source: Research findings.

As shown in the table, five clubs—Real Madrid, Barcelona, Manchester City, Liverpool, and Bayern Munich—achieved an efficiency score of 1, indicating that they form the efficiency frontier. Real Madrid and Barcelona are the highest-earning clubs of 2022, holding global rankings of 5 and 9, respectively. Bayern Munich, Manchester City, and Liverpool also demonstrate strong performance, with global ranks of 1, 2, and 3, respectively, and substantial revenues relative to other clubs. Moreover, Manchester City and Liverpool possess the highest total market values among all European clubs. Among other European clubs, technical efficiency scores range from 0.21 to 0.90, indicating varying degrees of inefficiency. Chelsea stands out as the most efficient club within this group, whereas Strasbourg is the least efficient.

In contrast, Iranian clubs display notably low efficiency scores, with pronounced inefficiencies across the board. Foolad Khuzestan and Sepahan exhibit the lowest inefficiency among Iranian clubs, approximately 0.97 units, followed closely by Esteghlal and Persepolis at 0.98. The greatest inefficiency is observed in Zob Ahan and Aluminium, with scores nearing 0.99 units.

However, considering the cost structures, revenue levels, and international rankings of Iranian football clubs, the efficiency scores obtained for them do not appear entirely unreasonable. Given that the primary objective of this study is to assess the growth potential

of Iran's football industry, it is possible to estimate the target output for Iranian clubs based on their current efficiency scores using the following formula:

$$\text{Target Output} = \frac{\text{Actual Output}}{\text{Efficiency Level}} \quad (2)$$

In the context of Data Envelopment Analysis (DEA), the target output represents the level of output that a club could theoretically achieve if it were operating efficiently, given its current level of inputs. In other words, the DEA model identifies the maximum attainable output without increasing input levels, and this output is considered the benchmark or target. Additionally, *output slack* in the DEA framework refers to the shortfall between the actual output and the target output. This shortfall quantifies the inefficiency associated with each output variable for a given club. The output deficit, calculated using the above formula, reflects the extent to which each club falls short of its efficient output level and can serve as a basis for estimating the unrealized potential in the industry.

$$\text{Output Slack} = \text{Actual Output} - \text{Target Output} \quad (3)$$

Based on equations (2) and (3), the target output and corresponding output slack for each output variable can be calculated for all clubs included in the study. The results of these calculations for Iranian football clubs are presented in Tables 3, 4, and 5, offering a detailed assessment of their performance gaps and unrealized output potential.

**Table 3. Target Total Revenue of Iranian Football Clubs (Million Euros)**

| Club             | Output Actual | Output Slack | Output Target |
|------------------|---------------|--------------|---------------|
| Sepahan          | 11841         | 461799       | 473640        |
| Gol Gohar Sirjan | 9230          | 602028.27    | 611258.27     |
| Foolad           | 8764          | 314630.83    | 323394.8      |
| Esteghlal        | 6185          | 377976.49    | 384161.49     |
| Persepolis       | 3232          | 182515.12    | 185747.12     |
| Zob Ahan         | 3107          | 366773.95    | 369880.95     |
| Aluminium        | 2735          | 393641.81    | 396376.81     |
| Paykan           | 2610          | 186520.43    | 189130.43     |

Source: Research findings.

Sepahan FC faces a revenue shortfall of €462 million in order to reach the efficiency frontier. By increasing its total revenue to €473 million, the club could operate at an efficient level. Gol Gohar FC has the largest revenue gap among Iranian football clubs, requiring an increase of €602 million to achieve a target revenue of €611 million and attain efficiency. Foolad Khuzestan FC would become efficient by raising its revenue by €314 million, reaching a total of €323 million. Similarly, Esteghlal and Persepolis FCs exhibit revenue shortfalls of €378 million and €182 million, respectively. To align with the efficiency frontier, their revenues would need to increase to €384 million and €185 million. The revenue deficits and corresponding efficiency benchmarks for Zob Ahan, Aluminium, and Peykan FCs are also reported in Table 3, all of which indicate substantial gaps between actual and target performance levels.

**Table 4: Target Global Ranking Values for Iranian Football Clubs**

| Club             | Output Actual | Output Slack  | Output Target |
|------------------|---------------|---------------|---------------|
| Sepahan          | 283 (0.003)   | -276 (0.137)  | 7 (0.141)     |
| Gol Gohar Sirjan | 987 (0.003)   | -972 (0.066)  | 15 (0.067)    |
| Foolad           | 293 (0.001)   | -285 (0.122)  | 8 (0.125)     |
| Esteghlal        | 130 (0.007)   | -128 (0.47)   | 2 (0.477)     |
| Persepolis       | 74 (0.013)    | -73 (0.763)   | 1 (0.776)     |
| Zob Ahan         | 451 (0.002)   | -448 (0.261)  | 3 (0.263)     |
| Aluminium        | 1482 (0.0006) | -1472 (0.097) | 10 (0.097)    |
| Paykan           | 826 (0.001)   | -815 (0.086)  | 11 (0.087)    |

Source: Research findings.

An important methodological consideration in applying the Data Envelopment Analysis model is the treatment of the global ranking variable. To ensure the correct interpretation within the DEA framework—where higher values represent better performance—the global rankings of clubs were transformed by taking the reciprocal of each club's ranking (i.e.,  $1/\text{rank}$ ). These transformed values were used in the EMS software for analysis. Accordingly, Table 4 presents the reciprocal values in parentheses for reference. However, to facilitate clearer interpretation and comparison, Table 4 also displays the actual global rankings, their target rankings required to reach the efficiency frontier, and the corresponding ranking gaps under the heading “Output Slack”.

Iranian football clubs currently hold relatively low positions in the global rankings. To reach the efficiency frontier, substantial improvements are required. For instance, Gol Gohar FC, currently ranked 987th globally, would need to improve to a rank of 15. Aluminium and Peykan FCs, ranked 1482 and 826 respectively, must reach global rankings of 10 and 11 to be deemed efficient. Similarly, Sepahan and Foolad Khuzestan FCs, with current global rankings of 283 and 293, need to improve to rankings below 10. Esteghlal, Persepolis, and Zob Ahan FCs—currently ranked 130, 74, and 451—would need to reach top 5 positions to operate efficiently according to the DEA model.

**Table 5: Target Market Value of Iranian Football Clubs (Million Euros)**

| Club             | Output Actual | Output Slack | Output Target |
|------------------|---------------|--------------|---------------|
| Sepahan          | 10025         | 390975       | 401000        |
| Gol Gohar Sirjan | 9250          | 603332.7     | 612582.7      |
| Foolad           | 17100         | 613896.31    | 630996.3      |
| Esteghlal        | 14675         | 896815.6     | 911490.6      |
| Persepolis       | 13025         | 735538.2     | 748563.2      |
| Zob Ahan         | 6800          | 802723.8     | 809523.8      |
| Aluminium        | 6050          | 870761.5     | 876811.5      |
| Paykan           | 7125          | 509179.34    | 516304.3      |

Source: Research findings.

**Estimation of Market Value Shortfalls and Industry-Level Growth Potential in Iranian Football:**

Sepahan Football Club can achieve efficiency by increasing its market value by €391 million, reaching a target of €401 million. Similarly, Gol Gohar and Foolad Khuzestan—with current market values of €9 million and €17 million—must raise their values to €612 million and €630 million, respectively, to become efficient. Esteghlal and Persepolis require increases of €896 million and €735 million, achieving target values of €911 million and €747 million. Other clubs, such as Zob Ahan, Aluminium, and Peykan, also face substantial gaps in market value to reach the efficiency frontier.

In frontier-based analytical models, inefficiency reflects the unrealized potential for performance improvement. Assuming uniform access to technology and technical knowledge across all units, a non-frontier decision-making unit (DMU) is deemed capable of achieving output levels equivalent to those of efficient peers. Based on this premise, the

growth and improvement potential of a single organization—or an entire industry—can be quantified. Accordingly, this study estimates the potential for performance enhancement across Iranian football clubs, particularly within the context of the Persian Gulf Pro League, which serves as the country's premier professional football league.

This league holds central importance in Iran's football landscape, both in athletic and economic terms. It attracts substantial media coverage, higher-caliber players, and significant sponsorships from global sports brands. In line with international studies, research efforts tend to focus on professional leagues due to their structural and financial prominence. Moreover, access to reliable data for professional clubs is comparatively better due to transparency and reporting requirements.

This analysis includes eight clubs from the Persian Gulf Pro League, selected based on data availability and financial prominence. While the league comprises 16 clubs, limitations in accessing consistent and complete data restricted the sample to the top-performing half. Notably, the combined market value of these eight clubs amounts to €83 million, accounting for approximately 60% of the league's total market value (€137 million, [Transfermarkt, 2022](#))<sup>1</sup>. Their combined salary expenditures also total €20 million—approximately 70% of the total salary expenses for all 16 clubs (€29 million, [Shahsavari, 2023](#))<sup>2</sup>. Taken together, the dataset representing these eight clubs captures an average of 65% of the Persian Gulf Pro League's financial and operational profile, making the sample both representative and analytically robust for evaluating industry-level efficiency and potential.

### Estimation of Iran's Professional Football Industry Potential and Comparative Benchmarking with Japan:

The potential capacity of Iran's professional football industry is calculated by determining the weighted average of optimal outputs. The weights for the data are derived using **Equation 4**, as follows:

$$\text{Weight of each club} = \frac{\text{Total actual revenue of the club} + \text{Total actual cost of the club}}{\text{Total actual revenue of the eight clubs studied} + \text{Total actual cost of the eight clubs studied}} \quad (4)$$

Using the output expansion formula applied to the eight Iranian football clubs under study, weights were calculated to determine each club's contribution to the league's potential output capacity. The weights were normalized such that their sum equals 1. These

<sup>1</sup> <https://www.transfermarkt.com/persian-gulf-pro-league/startseite/wettbewerb/IRN0>

<sup>2</sup> <https://www.isna.ir/news/1402040301269/>

weights were then used to compute the weighted optimal revenue and market value for each club. Summing the weighted values provided estimates of the potential output capacity of Iran's football industry based on this representative sample.

According to these calculations, the potential total revenue of Iran's professional football industry is estimated at €403 million. Given that the eight clubs studied represent an average of 65% of the Premier League's financial and operational structure, the total potential revenue of the league is extrapolated to €621 million. In contrast, the actual revenue of the eight clubs in 2022 was only €47 million, suggesting that the total revenue of the entire league was approximately €72 million. This results in a revenue shortfall of €549 million, highlighting the vast unrealized economic capacity of Iran's football sector. A similar gap is observed in terms of market value. According to [Transfermarkt \(2022\)](#)<sup>1</sup>, the actual market value of the entire Persian Gulf Pro League was €137 million. However, based on DEA model projections, the potential market value of just the eight analyzed clubs should have been €654 million. Scaling this figure to the full league, the total potential market value is estimated at approximately €1 billion, indicating a gap of €863 million compared to the actual 2022 value.

With regard to global rankings, the DEA analysis shows that Iranian clubs would need to significantly enhance their international performance to become efficient. Specifically, clubs would need to improve their rankings to be among the top 20, or ideally, top 10 globally, to align with the efficiency frontier. To validate these findings, Iran's football industry can be compared with that of another Asian country with a similar global standing. According to FIFA's 2022 ranking, Iran and Japan were ranked 23rd and 24th, respectively ([FIFA, 2024](#))<sup>2</sup>, making Japan a relevant benchmark. The J1 League in Japan generated ¥87 billion in 2022, equivalent to €612 million in revenue ([Statista, 2022](#))<sup>3</sup>, a figure closely matching Iran's estimated potential of €621 million. However, Japan's actual league market value stood at €316 million ([Transfermarkt, 2022](#))<sup>4</sup>, significantly lower than Iran's estimated €1 billion potential. This discrepancy can be attributed to different developmental models. Japan's football ecosystem focuses on talent development and exporting players rather than accumulating expensive international talent. Many top Japanese players transfer to European clubs once they reach professional status. Therefore, despite Japan's higher efficiency and sporting success, the lower market value of the J1 League is not unexpected and reflects strategic choices rather than inefficiencies.

1. [https://www.transfermarkt.com/persian-gulf-pro-league/startseite/wettbewerb/IRN0/plus/?saison\\_id=2120](https://www.transfermarkt.com/persian-gulf-pro-league/startseite/wettbewerb/IRN0/plus/?saison_id=2120)

2. <https://inside.fifa.com/fifa-world-ranking/men?dateId=id03991>

3. <https://www.statista.com/statistics/000009/japan-jleague-total-revenue-breakdown-by-division/>

4. <https://www.transfermarkt.com/j0-league/startseite/wettbewerb/JAP0>

## 5. Conclusions

This study offers a comprehensive evaluation of the technical and economic performance of Iran's professional football industry by applying the Data Envelopment Analysis (DEA) method. The analysis reveals a substantial gap between the current performance of Iranian football clubs and their potential capacity, particularly in terms of revenue generation, market value, and international rankings. These inefficiencies underscore the untapped economic and sporting potential of the industry and point to the urgent need for structural reforms.

### 5-1. Key Findings

**1. Structural and Financial Challenges:** Iran's football clubs operate under significant constraints, including underdeveloped infrastructure, the absence of stable broadcasting revenue, low ticket sales, and weak financial transparency. Combined with high operational costs and outdated governance models, these factors limit clubs' ability to generate sustainable income and improve performance.

**2. Significant Output Gaps:** The DEA model shows that Iranian clubs are operating far below their potential. The actual revenue of the top eight clubs in 2022 was just €47 million, while their estimated potential revenue is €403 million—highlighting a gap of €356 million. Extrapolated to the entire Premier League, the total revenue gap reaches approximately €549 million. A similar disparity exists in market value, where the league's actual valuation of €137 million falls significantly short of the €1 billion potential estimated in this study. These findings align with the Deloitte Football Money League (2025) report<sup>1</sup>, which shows that the average revenue of the top 20 European clubs has reached €560 million, with their total revenue exceeding €11.2 billion. In comparison, even the potential revenue of Iran's top football clubs—as estimated at €403 million using the DEA method—is approximately 28% lower than the European average, while their actual revenue covers only 8% of that amount. This striking gap highlights a profound inefficiency in economic performance and market utilization. Moreover, the current market value of the Iranian league stands at only 13.7% of its estimated potential, indicating a severe underutilization of the country's football assets and brand.

**3. Benchmarking with Japan:** A comparison with Japan's J1 League—an Asian peer with a similar FIFA ranking—demonstrates that Iran's potential is not aspirational but attainable. Despite Japan's leaner market valuation due to its focus on talent development

---

<sup>1</sup> <https://www.deloitte.com/uk/en/services/consulting-financial/analysis/deloitte-football-money-league.html>

over high-cost transfers, its revenue generation and overall league efficiency offer a clear model for Iran to emulate.

**4. Opportunities for Growth:** The widespread popularity of football in Iran, combined with the presence of internationally recognized players and the historical strength of clubs like Persepolis and Esteghlal, provides a strong foundation for growth. The industry's latent potential can be unlocked through strategic policy interventions.

**5. Policy Recommendations:** To address the identified inefficiencies and unlock growth, the study proposes the establishment of a specialized unit within the Ministry of Sport and Youth or the Iranian Football Federation. This unit should focus exclusively on the economic governance of football, promoting financial innovation, introducing modern regulatory tools, fostering investment, and overseeing club financial operations. Furthermore, institutional reforms are needed to increase transparency, strengthen commercial rights, and modernize the league's business model.

## 5-2. Final Remark

The findings of this study clearly show that Iran's football industry is far from reaching its productive and economic capacity. With evidence-based policies, better economic governance, and a reform-oriented institutional approach, Iranian football can move closer to global standards—both in terms of financial performance and competitive excellence.

## Acknowledgments

The authors would like to express their sincere gratitude to the anonymous reviewers for their valuable comments and suggestions, which significantly contributed to improving the quality and depth of this article.

## Observation Contribution

**Niloofer Maleki** collected and analyzed the data and prepared the initial draft of the manuscript. **Dr. Hamid Kordbacheh** supervised the research, guided the study, and contributed to the revision and finalization of the manuscript.

## Conflict of Interest

The authors declare that there is no financial or personal conflict of interest related to this research, and all ethical standards of publication have been observed.

## References

- Andreff, W. & Szymanski, S., (Eds.). (2006). *Handbook on the economics of sport*. Cheltenham, UK: Edward Elgar Publishing.
- Bason, T. & Senaux, B., (2023). "Chapter 1: The Football Industry". In R. Parrish & S. García (Eds.), *Research Handbook on the Law of Professional Football Clubs* (pp. 1–18). Edward Elgar Publishing. Available at: <https://pureportal.coventry.ac.uk/files/82578343/Bason2023AAM.pdf>.
- Capology., (2023). *Football salaries & finance*. Retrieved from <https://www.capology.com/>.
- Coelli, T. J., Rao, D. S. P., O'Donnell, C. J., & Battese, G. E., (2005). *An Introduction to Efficiency and Productivity Analysis* (2<sup>nd</sup> ed.). Springer.
- Deloitte., (2023). *Deloitte Football Money League 2023*. Deloitte Sports Business Group. Retrieved from <https://www2.deloitte.com/uk/en/pages/sports/articles/deloitte-football-money-league.html>.
- Deloitte., (2025). *Deloitte Football Money League 2025*. Retrieved from <https://www.deloitte.com/uk/en/services/consulting-financial/analysis/deloitte-football-money-league.html>.
- Esteghlal Cultural and Athletic Club., (2023). *Unaudited financial statements for the 12-month period ended July 22, 2023*. Codal – Comprehensive Database of All Listed Companies. Retrieved from <https://codal.ir/DownloadFile.aspx?hs=BenHOG6OOObOOO5cHc3ZNjwkXI9Q%3d%3d&ft=1005&let=6>.
- Fédération Internationale de Football Association (FIFA)., (2024). *FIFA/Coca-Cola Men's World Ranking – September 2024*. Retrieved from <https://inside.fifa.com/fifa-world-ranking/men?dateId=id13687>.
- Fédération Internationale de Football Association (FIFA)., (2022). *Professional Football – Annual Report 2021*. Retrieved from <https://publications.fifa.com/en/annual-report-2021/around-fifa/professional-football-2021/>.
- Fédération Internationale de Football Association (FIFA)., (2021). *The Football Landscape – The Vision 2020–2023*. Retrieved from <https://publications.fifa.com/en/vision-report-2021/the-football-landscape/>.
- Guzmán, I. & Morrow, S., (2007). "Measuring efficiency and productivity in professional football teams: Evidence from the English Premier League". *Central European Journal of Operations Research*, 15(4): 309–328. <https://doi.org/10.1007/s10100-007-0034-y>.

- Inside World Football., (2022, January 7). “AFC kicks Iranian giants Persepolis and Esteghlal out of Champions League”. Retrieved from <https://www.insideworldfootball.com/2022/01/07/afc-kicks-iranian-giants-persepolis-esteghlal-champions-league/>.
- Interesse, G., (2024, August 8). “China’s economic and sports industry gains from Paris 2024 Olympics”. *China Briefing*. Retrieved from <https://www.china-briefing.com/news/chinas-economic-and-sports-industry-gains-from-paris-2024-olympic-sports/>.
- Keskin, H. İ. & Öndes, H., (2020). “Measuring the efficiency of selected European football clubs: DEA and panel Tobit model”. *Sosyoekonomi*, 28(43): 153–174. <https://doi.org/10.17233/sosyoekonomi.2020.01.09>.
- KPMG Sports Advisory., (2020, March). *Sports industry economic analysis: Exploring the size and growth potential of the sport industry in Australia*. Office for Sport, Department of Health and Aged Care. Retrieved from <https://www.health.gov.au/sites/default/files/documents/2020/05/sports-industry-economic-analysis.pdf>.
- LALIGA., (2022). *LALIGA EA SPORTS 2021/22*. Retrieved from <https://www.laliga.com/en-GB/news/professional-football-in-spain-generates-more-than-194000-jobs-euro839-billion-in-taxes-and-accounts-for-144percent-of-gdp>.
- Moradi, J., Nazari, R. & Moradi, M., (2019). “Analysis of effective economic and financial barriers on development and sustainable performance of Iranian football industry based on Grounded Theory”. *Journal of Sport Management and Development*, 8(3): 153–166. <https://doi.org/10.22124/jsmd.2019.3799> (In Persian).
- Rezaei, S. & Esmaceli, M., (2019). “Broadcasting rights in the Iranian football industry”. *Journal of Sport Management and Development*, 8(3): 167–182. <https://doi.org/10.22124/jsmd.2019.3722> (In Persian).
- Seifpanahi Shabani, J., Khosromanesh, R. & Brakhas, H., (2022). “Designing a model: Factors affecting the sport performance and success of football clubs”. *New Trends in Sport Management*, 9(35): 161–177. <https://ntsmj.issma.ir/article-1-1807-en.html> (In Persian).
- Shahsavari, M. A., (2023, June 24). “Details of Premier League football clubs' expenses over the past three seasons + document”. *ISNA News Agency*. Retrieved from <https://www.isna.ir/news/1402040301269/> (In Persian).
- Šíma, J., Voráček, J., Kraft, J. & Krause, V., (2023). “Productive efficiency of Premier League teams using an enhanced data envelopment analysis approach”. *AUC Kınanthropologica*, 59(1): 29–44. <https://doi.org/10.14712/23366052.2023.3>.

- Smharun 121., (2025, January 21). “The Economic Impact of Football on Local and Global Levels”. *Toonstream*. Retrieved from <https://toonstream.org/the-economic-impact-of-football-on-local-and-global-levels/>.
- Statista., (2025). “Japan J.League total revenue breakdown by division”. *Statista*. Retrieved May 24, 2025, from <https://www.statista.com/statistics/944996/japan-jleague-total-revenue-breakdown-by-division/>.
- Transfermarkt., (2025). “J1 League”. *Transfermarkt*. Retrieved May 24, 2025, from <https://www.transfermarkt.com/j1-league/startseite/wettbewerb/JAP1>.
- Transfermarkt., (2025). “Persian Gulf Pro League 21/22”. *Transfermarkt*. Retrieved May 24, 2025, from [https://www.transfermarkt.com/persian-gulf-pro-league/startseite/wettbewerb/IRN1/saison\\_id/2021](https://www.transfermarkt.com/persian-gulf-pro-league/startseite/wettbewerb/IRN1/saison_id/2021).
- Viseu, J., (2000, September). “Economic sport demand determinants”. Paper presented at the 8th International Congress of the European Association of Sport Management (EASM), San Marino. Retrieved from <https://hdl.handle.net/1822/2786>.
- Wyszynski, A., (2016). “Efficiency of football clubs in Poland”. *Olsztyn Economic Journal*, 11(1): 59–72. <https://doi.org/10.31648/oiej.2902>.
- Weston, T. (2024, May 13). “Contribution of sport to society and the economy”. *House of Lords Library*. Retrieved from <https://lordslibrary.parliament.uk/contribution-of-sport-to-society-and-the-economy/>.
- Zolfaghari, M., Nobakht Ramazani, Z. & Naderi Nasab, M., (2019). “Designing an economic development model for Iranian Premier League football clubs”. *Strategic Studies on Youth and Sports*, 17(4): 11–36. [https://faslname.msy.gov.ir/article\\_544.html?lang=en](https://faslname.msy.gov.ir/article_544.html?lang=en) (In Persian).

## Appendix

### Appendix 1. Clubs studied

| Row | Club                | Row | Club             |
|-----|---------------------|-----|------------------|
| 1   | Real Madrid         | 25  | Roma             |
| 2   | Barcelona           | 26  | Napoli           |
| 3   | Manchester City     | 27  | Lyonnais         |
| 4   | Liverpool           | 28  | Koln             |
| 5   | Paris Saint-Germain | 29  | Lille            |
| 6   | Manchester United   | 30  | Hertha           |
| 7   | Bayern Munich       | 31  | Sassuolo         |
| 8   | Chelsea             | 32  | Lazio            |
| 9   | Borussia Dortmund   | 33  | Real Sociedad    |
| 10  | Juventus            | 34  | Real Betis       |
| 11  | Atletico de Madrid  | 35  | Valencia         |
| 12  | Arsenal             | 36  | Union Berlin     |
| 13  | Tottenham Hotspur   | 37  | Monaco           |
| 14  | Inter Milan         | 38  | Stade de Reims   |
| 15  | Leipzig             | 39  | Nice             |
| 16  | West Ham United     | 40  | Strasbourg       |
| 17  | Bayer Leverkusen    | 41  | Sepahan          |
| 18  | Wolfsburg           | 42  | Gol Gohar Sirjan |
| 19  | Leicester City      | 43  | Foolad           |
| 20  | AC Milan            | 44  | Esteghlal        |
| 21  | Marseille           | 45  | Persepolis       |
| 22  | Fiorentina          | 46  | Zob Ahan         |
| 23  | Sevilla             | 47  | Aluminium        |
| 24  | Villarreal          | 48  | Paykan           |





**فصلنامه علمی مطالعات اقتصادی کاربردی ایران**  
 شاپای چاپی: ۲۵۲۰-۲۳۲۲؛ شاپای الکترونیکی: ۴۷۲۲-۲۳۲۲ - وبسایت نشریه: <https://aes.basu.ac.ir>  
 نشریه گروه اقتصاد، دانشکده علوم اقتصادی و علوم اجتماعی، دانشگاه بوعلی سینا، همدان، ایران.  
 حق انتشار این مستند، متعلق به نویسنده (گان) آن است. ۱۴۴ - ناشر این مقاله، دانشگاه بوعلی سینا است.  
 این مقاله تحت گواهی زیر منتشر شده و هر نوع استفاده غیرتجاری از آن مشروط بر استناد صحیح به مقاله و با رعایت شرایط مندرج در آدرس زیر مجاز است.  
 آدرس زیر مجاز است.  
 Creative Commons Attribution-NonCommercial 4.0 International license (<https://creativecommons.org/licenses/by-nc/4.0/>)



## ارزیابی ظرفیت اقتصادی صنعت فوتبال ایران: تحلیل شکاف عملکرد

حمید کردبچه<sup>۱</sup>، نیلوفر ملکی<sup>۲</sup>

نوع مقاله: پژوهشی

شناسه دیجیتال: <https://doi.org/10.22084/aes.2025.30891.3786>

تاریخ دریافت: ۱۴۰۴/۰۷/۰۷، تاریخ بازنگری: ۱۴۰۴/۰۴/۰۹، تاریخ پذیرش: ۱۴۰۴/۰۴/۲۲

صص: ۹۳-۱۱۹

### چکیده

در جهان معاصر، ورزش به عنوان یکی از ارکان اساسی اقتصاد جهانی شناخته می شود و به یکی از صنایع مهم و پررونق تبدیل شده است. در این میان، فوتبال به دلیل محبوبیت گسترده و برخورداری از حدود ۴ میلیارد هوادار، جایگاه ویژه ای در صنعت ورزش به خود اختصاص داده است. فوتبال حرفه ای، نه تنها میلیون ها تماشاگر را در هر فصل جذب می کند، بلکه سهم قابل توجهی در ایجاد مشاغل و کسب و کارهای مرتبط دارد. باشگاه های فوتبال حرفه ای نیز به عنوان بنگاه های اقتصادی، به طور هم زمان در دو حوزه عملکرد ورزشی درون زمین و عملکرد مالی برون زمین با یک دیگر رقابت می کنند. این پژوهش با هدف ارزیابی ظرفیت بهبود عملکرد اقتصادی صنعت فوتبال ایران، از مدل مرزی بهره گرفته است. برای این منظور، از تکنیک ناپارامتریک تحلیل پوششی داده ها به منظور اندازه گیری کارایی فنی باشگاه های فوتبال ایران استفاده شده است. در این راستا، اطلاعات صورت های مالی باشگاه ها و امتیازات آن ها در رقابت ها به عنوان شاخص هایی برای سنجش عملکرد مورد بررسی قرار گرفته است. نمونه پژوهش شامل ۴۸ باشگاه از پنج لیگ بزرگ اروپا و لیگ برتر فوتبال ایران است. نتایج تحقیق نشان می دهد که ازمیان باشگاه های بررسی شده، تنها پنج باشگاه شامل دو باشگاه از لالیگای اسپانیا، دو باشگاه از لیگ برتر انگلستان و یک باشگاه از بوندسلیگای آلمان بر روی مرز کارایی فنی قرار دارند. در مقابل، باشگاه های فوتبال ایران در مقایسه با پنج لیگ بزرگ اروپا، فاصله چشمگیری با مرز کارایی فنی دارند و میزان ناکارایی آن ها بیش از ۹۰٪ برآورد شده است و نشان دهنده ظرفیت رشد ۷۰٪ در صنعت فوتبال ایران است.

**کلیدواژگان:** اقتصاد فوتبال، تحلیل پوششی داده ها، صنعت فوتبال ایران، ظرفیت بهبود بالقوه، ناکارایی.

**طبقه بندی JEL:** L83, C67, D24, O47

۱. دانشیار گروه اقتصاد، دانشکده علوم اجتماعی و اقتصاد، دانشگاه الزهراء، تهران، ایران (نویسنده مسئول).

Email: [h.kordbacheh@alzahra.ac.ir](mailto:h.kordbacheh@alzahra.ac.ir)

۲. دانشجوی کارشناسی ارشد اقتصاد، گروه اقتصاد، دانشکده علوم اجتماعی و اقتصاد، دانشگاه الزهراء، تهران، ایران.

Email: [Niloofarmaleki79@yahoo.com](mailto:Niloofarmaleki79@yahoo.com)



**Applied Economics Studies, Iran (AESI)**P. ISSN:2322-2530 & E. ISSN: 2322-472X - Journal Homepage: <https://aes.basu.ac.ir/>

Scientific Journal of Department of Economics, Faculty of Economic and Social Sciences, Bu-Ali Sina University, Hamadan, Iran. Owner &amp; Publisher: Bu-Ali Sina University.

© Copyright © 2025 The Authors. Published by Bu-Ali Sina University.

This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International license (<https://creativecommons.org/licenses/by-nc/4.0/>). Non-commercial uses of the work are permitted, provided the original work is properly cited.

# Stock Return Forecasting Using Dynamic Nonlinear Methods: Parametric and Nonparametric Modeling

Seyed Ehsan Hosseinidoust<sup>1</sup> , Mohammad Hassan Fotros<sup>2</sup> 

Type of Article: Research

 <https://doi.org/10.22084/aes.2025.31371.3815>

Received: 2025/08/03; Revised: 2025/08/23; Accepted: 2025/08/31

Pp: 121-151

## Abstract

Accurate stock market forecasting is a challenging and complex problem for the market analysts and decision makers. During the past decade's accuracy of different methods are examined yet there is no consensus on optimum forecasting method. In this regard, the main objective of present study is to investigate eligibility of nonlinear time series, such as exponential smoothing and regime-switching models beside Box-Jenkins scheme in forecasting of stock return time series. Data set consist of daily observations of Apple and Microsoft corporations as of 2024 to 2025. The Terasvirta-Lin-Granger procedure chaotic behavior of data generating process of the selected samples being examined. The Self-Exciting Threshold Autoregressive procedure combined with GARCH component (SETARMA-GARCH) and ARMA model combined with EGARCH component (ARMA-EGARCH) in order to capture the heterogeneous variance of financial time series, which yield dynamic hybrid models. Moreover, due to the overwhelming application of Artificial Intelligence methods in computation, besides the Exponential Smoothing (ES) approach as a non-parametric method, a recently developed Multilayer Perceptron Network (MLP) based on Feed-Forward-Back Propagation (FF-BP) algorithm being developed either. Both of the in-sample and out-sample forecasting are carried out and performance of models is evaluated using standard error criteria. Finally, the Diebold-Mariano test is employed in order to determine the significance of forecasting differences among the models. Findings indicated that the behavior of the return series for the both of the corporations are chaotic and nonlinear methods are appropriate in modeling. The exponential smoothing method outperformed the developed SETARMA-GARCH and ARMA-EGARCH procedures in terms of the majority of error criteria in the both of in-sample and out-sample forecasting. However, the MLP has outweighed the ES model based on every calculated error criteria. The estimated S-statistic of Diebold-Mariano test confirmed results of the forecasting in favor of the MLP method. This finding suggests application of the dynamic nonparametric methods in modeling and forecasting of the selected time series. Implication of such finding recommends use of dynamic nonlinear and nonparametric methods in financial series prediction.

**Keywords:** Stock Return Forecasting, Chaos Testing, Parametric and Nonparametric Methods, Dynamic Nonlinear Modeling, AI Approach.

**JEL Classification:** G11, G14, G17, G32.

1. Assistant Professor, Department of Economics, Faculty of Economics and Social Science, Bu-Ali Sina University, Hamedan, Iran (Corresponding Author). **Email:** [hosseinidoust@basu.ac.ir](mailto:hosseinidoust@basu.ac.ir)

2. Professor, Department of Economics, Faculty of Economics and Social Science, Bu-Ali Sina University, Hamedan, Iran.

**Citations:** Hosseinidoust, S. E. & Fotros, M. H., (2025). "Stock Return Forecasting Using Dynamic Nonlinear Methods: Parametric and Nonparametric Modeling". *Journal of Applied Economics Studies in Iran*, 14(55): 121-151. <https://doi.org/10.22084/aes.2025.31371.3815>

**Homepage of this Article:** [https://aes.basu.ac.ir/article\\_6227.html?lang=en](https://aes.basu.ac.ir/article_6227.html?lang=en)

## 1. Introduction

Last decades were witness of an increasing attention to nonlinear methods of econometrics and particularly in the field of time series modeling. Nonlinear forecasting is crucial because many real-world systems, like financial markets, exhibit complex, non-proportional relationships between variables that linear models cannot accurately capture. By employing nonlinear forecasting techniques, the more accurate predictions, better understand underlying dynamics, and more informed decisions in various fields we can be achieved. Regarding to the framework of financial time series modeling, there is large number of models, which are designed base on linear autoregressive procedure; or moving average approach or in more complete form of autoregressive-moving average (ARMA) model that initially has introduced by [Box & Jenkins \(1970\)](#). Box-Jenkins method suggests that the current value of dependent variable can be linearly expressed as a function of its previous values and residuals; hence called a linear procedure. Simple linear structure of such models caused their enormous application in the literature of empirical studies. However, there exist series that cannot be simply modeled by such linear process and exhibit, in some extend, nonlinear behavior as cannot be well-fitted by the general ARMA model. Such phenomenon suggests application of more complex structures like nonlinear methods. In the econometrics literature, wide range of nonlinear models there exists and selection of the optimum method or an appropriate form is an important issue. As it is argued by [Bradfield \(2007\)](#), [Brooks \(2008\)](#) and [Wang \(2009\)](#), selection of each model should not be only based on time series characteristics under consideration, but also self-characteristics of the model are required to be noted as well. In this way, model selection will be relevant to the model's degree of fitness with the features of time series is being analyzed. One of the popular nonlinear methods is procedure of regime switching.

Regime switching models are designed to capture discrete changes in the data generating process (DGP) of data under consideration. Threshold Autoregressive models (TAR) are generally referring to the piecewise-linear models or regime switching models. They addressed to  $\underline{z}$  number of autoregressive components which one process switches to another one due to a specific amount (named the threshold

value) of an independent variable. In TAR procedure, regime switching of dependent variable is due to the threshold value of an explanatory variable. As when as series cross over the threshold value, the process will shift to another regression line. Two different scenarios there exist in this sense, namely univariate and multivariate modeling, concerning to the number of included variables in the process of modeling. Hence, TAR model is considered as a multivariable model that is variation of dependent variable relying on the changes of independent variables. SETAR model is a special case of TAR schemes where regime switching is based on self-dynamics of the dependent variable; thus, SETAR model is considered as a univariate procedure. In the other words, unlike the TAR model that threshold value depends on an exogenous variable, in SETAR model threshold value is related to the endogenous variable. SETAR model initially is introduced by [Tong \(1978\)](#) and developed by [Tong and Lim \(1980\)](#) and [Tong \(1983\)](#). Motivated by study on complex nonlinear discrete systems, Tong developed a special type of time series models that would be able to regenerate properties of the original data generating process (DGP) of a sample series. This model hypothesized different AR process based on different threshold values. Advantages of using SETAR model are reflected in its abilities of producing several commonly observed phenomena, such as irreversibility, jumps, and limit cycles, which cannot be captured by the naive linear models such as ARMA model. In addition, regarding to the stylized facts of financial time series, volatility clustering is one of the indispensable features of such series that reveals in existence of a heterogeneous variance. In order to capture such phenomenon, [Engle \(1982\)](#) introduced Autoregressive Conditional Heteroscedasticity (ARCH) model by contriving an autoregressive (AR) form for variance equation. Following to Engle's innovation, [Bollerslev \(1986\)](#) introduced Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model through introducing additional moving average component in the conditional variance equation and therefore variance equation resembling an ARMA structure. Capability of GARCH procedure in capturing the conditional variance of financial series is proved in the literature of financial time series and largely has utilized in the empirical studies. Therefore, although SETARMA models excel at capturing how time series evolve over time,

including changes in regimes and behaviors, but merging of this model with a GARCH component can capture the nonlinear of regime changing and shifts from periods of low volatility to high volatility, which linear models struggle to represent. Hence, the enhanced SETARMA-GARCH model can provide better estimates of uncertainty and risk management for different scenarios. Likewise, Simple linear models such as AR, MA and ARMA assume a fixed and direct impact from exo-variables to endo-variables, but many systems involve complex interactions where the impact of one variable changes depending on the state of others or the level of volatility. For example, the financial markets and stock prices in particular have periods of high and low volatility behavior; in which, enhancing the mentioned models by volatility models (such as ARCH and GARCH family models) seems necessary. Therefore, such combination is implemented in the present study and EGARCH component is merged to ARMA model to improve the accuracy of forecasting. The reason of selection of EGARCH model reflected in the advantage of this method in asymmetric behavior capturing. Meaning that, good news and bad news with the same magnitude in the financial markets do not have the same effect on the market. Usually, bad news more amplified the volatility of the stock markets than the good ones of the same weight. In comparison with the previous studies, such hybrid modeling brought relative novelty to the current study.

Artificial Neural Network (ANN) is a computer simulation model of the human brain. Neural networks are considered similar as the fundamental functional source of intelligence that includes perception, cognition, and learning for humans. Similar to human brain that is a collection of millions natural neurons, an ANN is also made of a collection of neurons. A combination of neurons that are related and connected to each other, construct a network that is known as a neural network. Results of many studies are in favor of the accuracy of ANN methods in financial markets forecasting (e.g [Khadiri et al., \(2025\)](#), [Gajdosikova & Michulek \(2025\)](#), [Zheng et al., \(2024\)](#), [Pattanayak & Swetapadma \(2024\)](#), [Audrey et al., \(2023\)](#), [Kurani et al., \(2023\)](#), [Hosseinidoust et al., \(2016\)](#)). However, outcomes of some other studies have shown the precision of the econometrics models rather than the ANN methods (i.e [Tripathi et al., \(2025\)](#), [Jin & Xu \(2025\)](#), [Zakhidov \(2024\)](#), [Song et al., \(2024\)](#)).

Thus, the present study aims to shed more light on this conflict and reexamining and comparing the accuracy of the mentioned methods rather than each other.

Therefore, in the current study with regard to the importance of stock return forecasting, especially in the internationally integrated stock market and due to the inexistence of a global consensus about the eligibility of nonlinear models' simulation and prediction, a Self-Exciting Threshold Autoregressive Moving-Average (SETARMA) model is combined with a Generalized Autoregressive Conditional Heteroscedasticity (GARCH) component to obtain the SETARMA-GARCH model. In addition, pay attention to the privilege of Exponential Smoothing (ES) method that is unlike the simple moving average that weights the past observations equally; exponential smoothing assigns exponentially decreasing weights over time and the ES method included in the present study as well. In order to have a comparison benchmark, developed hybrid SETAR-GARCH model and ES procedure are compared to another hybrid system that is linear ARMA combined with EGARCH process, which is ARMA-EGARCH model. As mentioned earlier, these models are compared to ANN method. All of these methods are employed for Apple and Microsoft corporations' stock return time series modeling and prediction in the form of in-sample and out-sample forecasting. Precision of each model is measured in terms of error criteria such as Mean Absolute Percentage Error (MAPE), Root Mean Squared Error (RMSE), Bias Proportion (BP) and Variance Proportion (VP).

The structure of this study is as; first, some of the previous researches are mentioned in brief. Then, implemented methods and data sets will be introduced. At the end, conclusion of this research will be represented after detailed discussion about the empirical findings of the study.

## 2. Literature Review

Utilization of the nonlinear methods in time series forecasting goes back to the seminal works in 1980's that the nonlinear dynamic models became one of the most popular methodologies in the study of time series. Recently, the comparison between basic-statistical models and AI models has attracted the attention of researchers; for instance, [Jin & Xu \(2025\)](#) have investigated the real state sector of

China stock market using the quarterly national residential property price indices from 2005 to 2024 by using Gaussian process regressions with a variety of kernels and basic functions. For the purpose of model training and conducting forecasting exercises using the estimated models, cross-validation and Bayesian optimizations based upon the expected improvement per second plus algorithm are implemented. Findings showed that the constructed Gaussian process regression model outperformed several alternative machine learning models and econometric models. Their forecast performance is robust to different out-of-sample evaluation periods as well. Likewise, the comparison between sentiment models and short- and long-term memory AI models has also been investigated in some studies; for example, [Tripathi et al., \(2025\)](#) addressed the challenges of econometric model and AI methods by proposing a hybrid model that integrates a Convolutional Long Short-Term Memory (LSTM) network. Using a two-year dataset of historical stock prices from HDFC Bank and incorporating sentiment analysis to capture the impact of market sentiment on price trends. Sentiment Analysis are carried out using major parameters in a Random Forest model to provide an additional sentiment-based input to the LSTM model. Results indicate that the LSTM model achieves a lower RMSE, MAE and MAPE showcasing strong alignment between predicted and actual prices. Findings representing underscoring the potential of hybrid machine learning architectures for financial time series forecasting.

Moreover, [Zakhidov \(2024\)](#) explored the pivotal role of economic indicators as indispensable tools for comprehending market trends and forecasting future performance. The research elucidated the significance of economic indicators in guiding strategic decision-making for businesses, investors, and governments alike. Through empirical analysis and theoretical frameworks, it demonstrated how these indicators serve as barometers of economic stability, aiding in risk assessment, trend identification, and the formulation of proactive strategies.

In addition, the comparison of forecasting accuracy between AI models and Markov switching models has been investigated in various studies. In this regard, [Song & Song \(2024\)](#) introduced a hybrid AI architecture for simultaneous risk quantification and return prediction across global equity markets. Analyzing stocks 2018-2023 with 128 financial data in a framework innovatively combined Risk

Encoding, Attention-based sector risk spillover networks and Temporal Modeling and Regime-switching detection via hidden Markov models. Outcomes implies that the hybrid AI model has a significant efficiency in stock market forecasting based on the low levels of error generated.

Besides, [Hosseinidoust et al., \(2016\)](#) concentrated on the application of dynamic parametric and non-parametric systems in stock market forecasting of Tehran stock exchange market. The study focuses on two different methods namely dynamic-parametric method of ARMA-PGARCH and dynamic-nonparametric procedure of NARX artificial neural network. Predictions are exerted in the form of in-sample and out-sample using daily observations of TEPIX from 1997 to 2015. Forecasting horizon of next five working days has adopted for the out-sample prediction and eight error criteria are picked out in order to assess accuracy of each approach. Outcomes of implied higher precision of the dynamic neural network performance in comparison with the parametric method of ARMA-PGARCH. In addition, the results are in favor of inexistence of weak-form of informational efficiency in Tehran stock market.

[Calin et al., \(2014\)](#) discussed a wide range of nonlinear methods of time series such as multivariate and univariate Threshold models (e.g. TAR, SETAR and SETARMA) and volatility models (e.g. ARCH, GARCH, GJR-GARCH, EGARCH etc.) and concluded that the nonlinear models have remarkable performance in forecasting of the financial time series. The out-sample predictability of different GARCH models for various horizons is investigated by [Awartani & Corradi \(2005\)](#) employing daily observations of S&P500 index by means of different GARCH-family models. Outcomes imply higher accuracy of the asymmetric GARCH models in comparison against the first generation of ARCH-family models. [Leung et al., \(2000\)](#) developed various level estimation methods (i.e. adaptive exponential smoothing, VAR and multivariate neural network) and classification models (Logit, Probit and Probabilistic neural networks) for prediction of return and for direction of return of S & P500, FTSE100 and Nikkei for various periods. Results are generally in favor of the classification models and lower performance of the level estimation methods. The principal index of Brazilian stock market is studied by [Faria et al., \(2004\)](#) based on adaptive exponential

smoothing method and artificial neural network. Findings represented higher precision of neural network than the adaptive exponential smoothing method.

A glance on the application of regime switching models shows large number of empirical researches using these models in the exchange markets and macroeconomic variables. For instance, [Engle \(1994\)](#), [Bergman & Hansson \(2005\)](#), [Ismail & Isa \(2006\)](#) developed regime switching models for exchange rate and their findings exhibit higher precision of these models in the both in-sample and out-sample forecasting. Likewise, [De Gooijer & Komar \(1992\)](#), [Potter \(1995\)](#) and [Peel & Speight \(1998\)](#) developed SETAR models for modeling the GDP of different countries such as UK and US and their results indicate that switching models outperformed linear approaches. Moreover, [Clements & Smith \(1999\)](#) investigated the multi-period forecast performance of a number of empirical SETAR models for modeling the exchange rates and GNP either and results are in favor of higher performance of SETAR model than the linear models such as AR and MA.

In the field of stock market forecasting, [Chang and Lam \(2010\)](#) attempted to capture stock market return asymmetry and investigate the predictability of trading strategies based on SETAR model for Hong Kong and Singapore stock markets. Their findings imply efficiency of SETAR model in stock market forecasting. Furthermore, [Terence \*et al.\*, \(2009\)](#) compared performance of SETAR procedure with other models such as autoregressive model and moving average model using four major indices of China stock markets namely Shanghai and Shenzhen A and B share indices. Findings of this study indicate that the SETAR model has outperformed AR and MA models based on employed forecasting error criteria.

As can be seen from the research background, despite the existence of numerous studies in the field of forecasting and nonlinear modeling, very few studies have resorted to the use of hybrid models and combination of Mean-Equation modeling with Variance-Equation or volatility models. Thus, in the previous studies, comparisons between parametric (such as regime switching models) and nonparametric (such as exponential smoothing models) models have rarely been paid attention. In addition, comparisons of AI models with hybrid regime switching models have been very few. Therefore, it seems the present study can be innovative in these respects.

### 3. Methodology and Data

Data set of current study involves daily observations of Apple and Microsoft stock prices as two famous high-tech companies. Based on monthly “Market Watch”<sup>1</sup> reports in Jun 2015, these companies stand among the top active corporations in the international stock market. Data spans from 7<sup>th</sup> Aug 2024 to 7<sup>th</sup> Aug 2025 that covers daily observations within a year.

To check the level of integration of time series, two different types of unit root tests are employed namely Augmented [Dickey-Fuller \(1979\)](#) or ADF in short, and [Zivot-Andrews \(1992\)](#) unit root test, or ZA. The ADF unit root test is one of the most popular procedures utilized for finding stationarity of a time series. Results of this test might be misleading if there exist structural break or level shift at the series in hand. Therefore, due to the capability of Zivot-Andrews test in capturing stationarity by taking structural break or level shift into account, this test besides ADF test is employed in the current study. Afterwards, based on suggested procedure by [Terasvirta et al., \(1993\)](#) linearity or nonlinearity of time series will be examined to shed more light on existence of chaos in the selected time series. This method is neural-network based test and the null hypothesis consists of linearity in the mean equation. Using Taylor series expansion, this method estimate a test-statistic based on Chi squared-statistic and F-statistic. Moreover, Recursive Least Square (RLS) estimation is implemented to achieve threshold value of SETAR-GARCH model. All the developed models are examined using the popular diagnostic procedures such as ARCH-heteroscedasticity and Ljung-Box serial correlation tests. Results of the diagnostic tests are helpful to confirm validation of developed models. Eventually, the models are employed for the in-sample and out-sample forecasting. Forecasting horizon of the out-sample forecasting is next five working days. Accuracy of the developed model is computed based on error criteria, such as Mean Squared Error (MSE), Mean Absolute Percentage Error (MAPE), Bias Proportion (BP) and Variance Proportion (VP). Significance of the obtained differences is examined using the proposed procedure by Diebold-Mariano (1995). The focus of the current study is on Apple and Microsoft companies’ stock returns, that are calculated based on the following formula:

---

<sup>1</sup> <https://www.marketwatch.com>

$$R_t = \ln \left( \frac{P_t}{P_{t-1}} \right)$$

ARMA model originally is setup by [Box & Jenkins \(1976\)](#) and consists of two components as autoregressive and moving average and its general structure is shown in equation (1).

$$Y_t = \theta + \sum_{j=1}^p \beta_j u_{t-j} + \sum_{i=1}^q \alpha_i Y_{t-i} \quad (1)$$

Where  $Y_{t-i}$  indicates autoregressive component with order ( $q$ ) and  $u_{t-j}$  suggests moving average part of order ( $p$ ). ARMA model is capable in capturing mean equation behavior and in present study it will be combined by Exponential-GARCH method model of volatility. This combination causes that the mean and variance of financial series being involved in the modeling at the same time. The EGARCH model developed by [Nelson \(1991\)](#) in which the natural logarithm of the conditional variance is allowed to vary over times as a function of the lagged error terms rather than lagged squared one. General form of EGARCH model is presented by equation (2).

$$\log(\sigma_t^2) = + \sum_{j=1}^q \beta_j \log(\sigma_{t-j}^2) + \sum_{i=1}^p \alpha_i \left| \frac{\varepsilon_{t-i}}{\sigma_{t-i}} \right| + \sum_{k=1}^r \gamma_k \left( \frac{\varepsilon_{t-k}}{\sigma_{t-k}} \right) \quad (2)$$

The exponential nature of the EGARCH ensures that the conditional variance can never be negative. Likewise, presence of the leverage effects can be stated by the hypothesis of  $\gamma_k < 0$  whereas the impact is asymmetric if  $\gamma_k \neq 0$ . Combination of ARMA and EGARCH models results in geniture a powerful hybrid model that is qualified to model mean and variance equation simultaneously and potentially reduce the level of forecasting errors.

SETAR model first proposed by [Tong \(1987\)](#) and its basic idea is to introduce  $l-1$  thresholds  $r_j (j=1, 2, \dots, l-1)$  in the range of a time series and dividing time axis into  $l$  ranges. It distributes observation sequence  $\{x(t)\}$  into different threshold ranges according to the value of  $\{x(t-d)\}$  by delay steps ( $d$ ) and then adopts different autoregressive models to clarify time series under consideration as a whole. General structure of SETAR model is represented by equation (3).

$$Y_t = I_t \left[ \alpha_{10} + \sum_{i=1}^p \alpha_{1i} Y_{t-i} \right] + (1 - I_t) \left[ \alpha_{20} + \sum_{i=1}^r \alpha_{2i} Y_{t-i} \right] + \varepsilon_t \quad (3)$$

Where the error term is a white noise process and  $I_t$  is an indicator function such as:

$$I_t = 1 \text{ if } Y_{t-1} > \tau, I_t = 0 \text{ if } Y_{t-1} \leq \tau$$

Where  $\tau$  is the threshold value, which separates regimes. A more general format of SETAR model can represent by a piecewise equation like equation (4).

SETAR model is empowered through combining with Generalized ARCH (GARCH) model. This model initiated by [Bollerslev \(1986\)](#) proposing joint estimation of both conditional mean and a conditional variance equation as shown in equations (5) and (6).

$$y_t = c + \beta y_{t-1} + \varepsilon_t \quad (5)$$

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^q \beta_i u_{t-i}^2 + \sum_{j=1}^p \gamma_j \sigma_{t-j}^2 \quad (6)$$

$y_t$  indicates the mean equation with autoregressive form of order one and  $\sigma_t^2$  representing the conditional variance equation. This function states that the variance ( $\sigma_t^2$ ) of  $u$  at time  $t$  depends not only on the squared error term in the periods before, but also depends on its conditional variance at the previous periods.

In addition, in order to introduce the threshold value to the SETR-GARCH model, residuals of the recursive least square (RLS) estimation is adopted, in which the equation is estimated repeatedly using ever larger subsets of the sample data. Readily, if there are  $k$  coefficients to be estimated in the  $b$  vector, then the first  $k$  observations are used to form the first estimate of  $b$ . Residuals of RLS method are extracted from equation (7):

$$w_t = \frac{y_t - x_t' b}{\left(1 + x_t' (X_{t-1}' X_{t-1})^{-1} x_t\right)^{1/2}} \quad (7)$$

Where,  $X_t$  is matrix of regressors at time  $t$ ,  $y_{t-1}$  represents vector of observations on the dependent variable,  $b_{t-1}$  stands for estimated coefficient vector and  $x_{t-1}' b$  shows vector of forecasted values. Exponential smoothing (ES) is a simple method of adaptive forecasting discussed by [Bowerman & O'Connell \(1979\)](#). Its advantage compared to regression models is that ES method does not utilize fixed coefficients

and forecasts from this procedure adjust based upon past forecast errors. Two general form of this approach is introduced as simple ES and Error-Trend-Seasonal ES or ETS-ES. The single form of ES computes smoothed series  $\hat{x}_t$  of  $x_t$  recursively by evaluation of equation (8).

$$\hat{x}_t = \alpha x_t + (1 - \alpha) \hat{x}_{t-1} \Rightarrow \hat{x}_t = \alpha \sum_{s=0}^{t-1} (1 - \alpha)^s x_{t-s} \quad (8)$$

Where,  $0 < \alpha \leq 1$  is the smoothing or damping factor. ETS-ES method originated by Hyndman *et al.*, (2002) and decomposed time series into three components of trend (T), seasonal (S), and error (E), where the trend term characterizes the long-term movement of time series, the seasonal term corresponds to a pattern with known periodicity and the error term is the irregular and unpredictable component of series. The simplest specification of ETS-ES with exclusion of trend and seasonal innovations is as follow:

$$\begin{cases} x_t = l_{t-1} + \varepsilon_t \\ l_t = l_{t-1} + \alpha \varepsilon_t \end{cases}$$

Where  $x_t$  represents prediction error equation and  $l_t$  exhibits the weighted average of the current value of the variable and its forecasted value. As mentioned by Hyndman *et al.*, (2008), Holt's approach of ETS-ES considers a linear trend method with multiplicative errors. Halt's approach of ETS-ES can be summarized as below:

$$\begin{cases} y_t = (l_{t-1} + b_{t-1})(1 + e_t) \\ l_t = (l_{t-1} + b_{t-1})(1 + \alpha e_t) \\ b_t = b_{t-1} + \beta (l_{t-1} + b_{t-1}) e_t \end{cases}$$

Where  $b_t$  shows the growth components of trend,  $l_t$  is the level component of time trend and  $Y_t$  implying the current value of the variable and its forecasted value.

Moreover, present study utilizes the suggested procedure by Diebold & Mariano (1995) in order to determine whether the computed forecasting errors of the distinctive models are significantly different. Given two forecasting error time series  $e_1$  and  $e_2$ , a loss function such as  $d_t$  is defined such that:

$$d = f(e_1) - f(e_2)$$

Where, the  $(f)$  function can adopt two forms of squaring or absolute function. The developed loss function will be employed in the computation of S-statistic. Thus, the Diebold-Mariano test statistic can be defined by equation (9).

$$S = [\hat{V}(\bar{d})]^{-1/2}(\bar{d}) \quad (9)$$

Where,  $\hat{V}(\bar{d})$  is the asymptotic variance of the mean of the difference between the forecasting errors as  $\hat{V}(\bar{d}) \approx n^{-1}[\gamma_0 + 2\sum \gamma_k]$  and  $\gamma_k$  is the  $k^{\text{th}}$  auto covariance of loss function. The hypothesis testing of this procedure is defined as follow:

$$\begin{cases} H_0 : E[f(e_1)] = E[f(e_2)] \\ H_1 : E[f(e_1)] \neq E[f(e_2)] \end{cases}$$

If the computed S-statistic is negative and significant, the conclusion is that the first model is significantly dominant and more accurate than the second model. Diebold and Mariano test follows an asymptotic standard normal distribution.

In the present study a Multilayer Perceptron Network (MLP), which is a subset of Feed-Forward Networks, with Back-Propagation error correction algorithm (BP) is employed. This network includes three major layers as the first layer (or input layer) gathering and transmit them in to the next layer by multiplying them in random weights. The second layer (or hidden layer) processes the data in the core of neurons and multiplies them with random weights before transmitting them to the last layer (output layer). The third layer is the output layer, which generates the output of the system. At this point, the feed-forward algorithm has completed its duty. The Back-Propagation (BP) algorithm compares results of the feed-forward process with the actual data to compute error of procedure and spreads this error through the network in the opposite direction that feed-forward does. All the weights that were randomly assigned at the beginning are refined and revised in such a way that the network produces the ideal output. The process has repeated several times until the network reaches the determined level of error criterion. The process is depicted in figure (1).

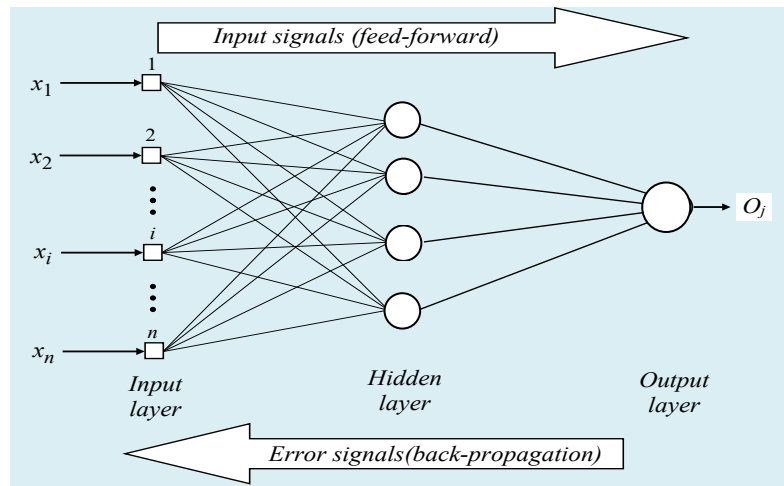


Fig. 1: Directions of data spread and error propagation (Munakat, 2008).

#### 4. Empirical Findings

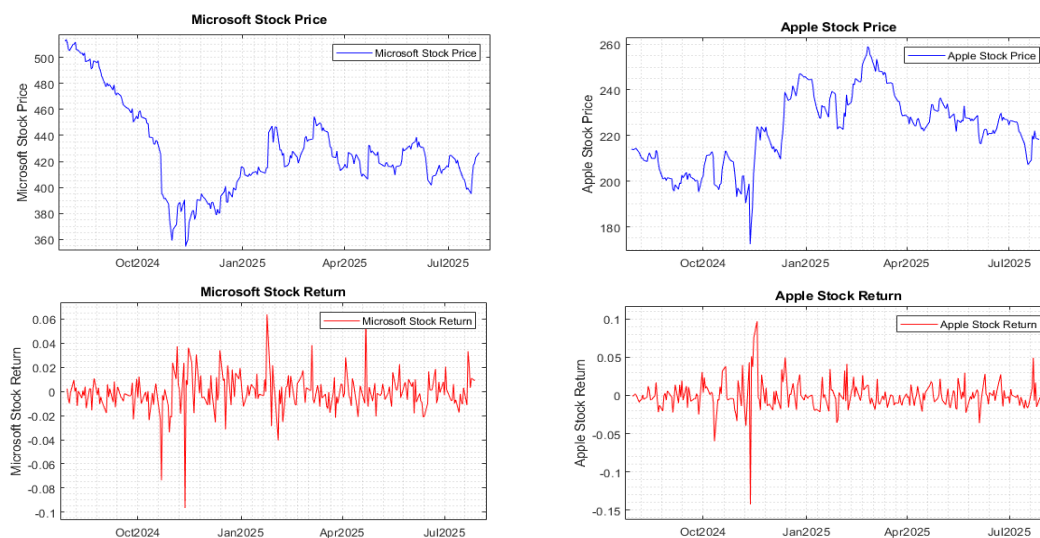
Table 1. Descriptive Statistics

| Series Name            | Mean      | Max    | Min    | Std.dev | Skewness | Kurtosis | Jarque-Bera<br>(Prob) |
|------------------------|-----------|--------|--------|---------|----------|----------|-----------------------|
| Apple Stock Price      | 222.14    | 250.05 | 172.42 | 15.98   | -0.08    | 2.59     | 1.98<br>(0.36)        |
| Apple Stock Return     | -7.79E-05 | 0.14   | -0.09  | 0.02    | 0.57     | 15.92    | 1745<br>(0.00)        |
| Microsoft Stock Price  | 428.22    | 513.71 | 354.56 | 34.43   | 0.65     | 3.16     | 18.20<br>(0.00)       |
| Microsoft Stock Return | 0.0001    | 0.09   | -0.06  | 0.01    | 0.64     | 11.71    | 803<br>(0.00)         |

(Research Findings).

Before interpretation of results of unit root tests, plots of Apple and Microsoft stock prices and returns are depicted in figure (2) and summary of descriptive statistics are reported in table (1).

Referring to table (1), Apple stock price is lower than the Microsoft in terms of Min-Max and on average. However, the risk of Apple stock price that is computing based on the Std. dev is much lower than the opponent company. The distribution of Apple stock price is normal basing the Jarque-Bera test but for the Microsoft it is not. Having a glance to the return series, the average of return on investment on the Apple stocks is higher than the Microsoft and it has higher risk as well. The both of the return series are not normally distributed within the selected period.



**Fig. 2: Daily Stock Prices and Returns of Apple & Microsoft Corporations (Research Findings).**

Graphically and with regard to the plotted figures of stock price of the both mentioned corporations, several upward and downward trends are apparent. Therefore, it implies inexistence of stationary in the stock price time series. However, return time series fluctuations are around the origin line implying stationarity of these series. Graphical interpretations are not sufficient and statistical tests are required to check the stationary issue. Therefore, stationary tests of Augmented Dickey-Fuller (ADF) and Zivot-Andrews (ZA) are carried out and their results are summarized in table (2).

Note that the both tests are executed in two forms, first only by inclusion of intercept and secondly by inclusion of trend and intercept. Results of ADF test clearly suggest that price indices are nonstationary. Due to the insignificant obtained t-statistics, the null hypothesis testing that claims existence of unit root procedure cannot be rejected; hence, there is unit root problem in the price series and they are nonstationary. Implementing ADF test on the computed return series suggests that the return series are stationary referring to the significant obtained t-statistics. This finding indicates rejection of null hypothesis of this test in favor of inexistence of unit root phenomenon; therefore, the computed return series are stationary.

Table 2: Results of Unit Root Test

| Type of Test | Test on the Apple Stock Price |                             | Test on the Apple Stock Return |                             |
|--------------|-------------------------------|-----------------------------|--------------------------------|-----------------------------|
|              | Including Intercept           | Including Trend & Intercept | Including Intercept            | Including Trend & Intercept |
| <i>ADF</i>   | -2.1713                       | -2.6781                     | -15.4452**                     | -15.4441**                  |
| <i>ZA</i>    | -2.8791                       | -2.9941                     | -42.5965***                    | -42.5853***                 |

|            | Test on the Microsoft Stock Price |                             | Test on the Microsoft Stock Return |                             |
|------------|-----------------------------------|-----------------------------|------------------------------------|-----------------------------|
|            | Including Intercept               | Including Trend & Intercept | Including Intercept                | Including Trend & Intercept |
| <i>ADF</i> | -3.2351                           | -3.3269                     | -51.8143***                        | -51.8250***                 |
| <i>ZA</i>  | -2.9328                           | -2.0398                     | -51.8571***                        | -51.8695***                 |

**Notice:** \*, \*\*, \*\*\* denote significant at the 10%, 5% and 1% level respectively (Research Findings).

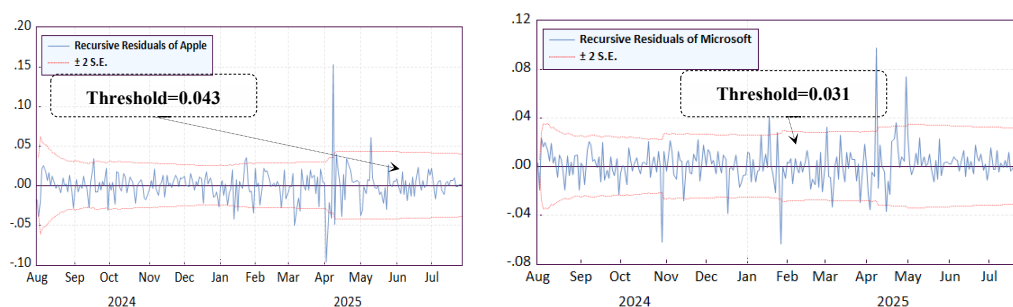
Although ADF results offering that the return series is stationary but due to the sample range and concerning to the recessions and market crash events during selected sample range, it is not convenience to merely relay on the ADF results and advanced type of unit root testing is required to carry out. As it mentioned earlier, Zivot-Andrews unit root test is employed and its results are reported in table (2). Interestingly, ZA results support findings of ADF test in favor of stationarity of the return series and non-stationarity of the price indices even at the presence of break in these time series (break point is highlighted by dash line). Therefore, as the result of unit root tests, in order to prevent having a spurious regression, the return time series should be used in the modeling procedure. In the next step, in order to shed more light on the matter of nonlinearity and existence of chaos in the return of the Apple and Microsoft stock return time series, test of [Terasvirta et al., \(1993\)](#) is carried out and its outcomes are tabulated in table (3).

Table 3. Results of Terasvirta-Lin-Granger Chaos Test

| Name of Time Series    | Estimated F-statistic | Estimated Chi <sup>2</sup> -statistic |
|------------------------|-----------------------|---------------------------------------|
| Apple Stock Price      | 0.7517<br>(0.63429)   | 5.4881<br>(0.7348)                    |
| Apple Stock Return     | 0.7018<br>(0.6704)    | 5.1313<br>(0.6439)                    |
| Microsoft Stock Price  | 0.6433<br>(0.8461)    | 4.7255<br>(0.8859)                    |
| Microsoft Stock Return | 0.5926<br>(0.8963)    | 4.6703<br>(0.8878)                    |

**Note:** Reported Values in Parentheses are Estimated Probabilities (Research Findings).

Remind that the null hypothesis indicates that the time series is linear and there is not enough evidence for the presence of chaos. With regard to the estimated “F” and “Chi-sqr” coefficients and especially referring to the estimated P-values, which are insignificant at 95% level of significant, the null hypothesis cannot be accepted and it can be concluded that stock price and their associated return time series have represented evidence on the existence of nonlinearity or chaos in their data generating process. This finding advises application of nonlinear models. Therefore, the return series should be used in the modeling as the results of the unit root tests and nonlinear types of models should be chosen for the modeling purposes. Selection of AR and MA orders also ARCH and GARCH components of ARMA-EGARCH model are based on the parsimony principle, which suggesting inclusion of lower orders of components that satisfying conventional diagnostic tests of modeling, such as heteroscedasticity, serial-correlation, normality and etc. In this regard, suggested ARMA-EGARCH model for Apple corporation is ARMA (1,1)-EGARCH (1,1,1) and for Microsoft company is ARMA(1,1)-EGARCH(1,1,1). Furthermore, outcomes of executed RLS method for threshold value detection in the both time series is plotted in figure (3).



**Fig. 3: Results of Recursive Least Square Method (Research Findings).**

In developing the SETAR model and in order to reduce the degree of model complexity, similar to other studies (i.e. [Ismail & Isa \(2006\)](#)) an equal number of lag and delay parameter is adopted for every regime. The controversial problem dealing with SETAR models is determination of threshold value. In present study, RLS method is employed to deal with such problem. Based on RLS out comes, suggested threshold value for Microsoft and Apple stock return is 0.15 and 0.09

respectively, which results are depicted in figure (3). The established SETAR-TGARCH model upon the extracted threshold values are SETARMA (1,2)-GARCH(1,1) and SETARMA(2,2)-GARCH(1,1) for Apple and Microsoft stock return relatively. In order to check whether the developed ARMA-EGARCH and SETAR-GARCH models are statistically significant, diagnostic tests such as Ljung-Box serial-correlation and the ARCH-heteroscedasticity test are implemented and their results are summarized in table (4). Referring to the estimated Q-statistic of Ljung-Box test that is insignificant, it can be concluded that there is no serial-correlation problem in the developed models. The conclusion is same for the ARCH-heteroscedasticity test and estimated coefficients for F-statistic and  $\text{Chi}^2$ -statistic are insignificant, implying that there is no heteroscedasticity problem in the constructed models. Therefore, results of the diagnostic tests confirm that the developed ARMA-EGARCH and SETARMA-GARCH models are statistically valid and can be employed for forecasting purposes. Regarding to the speed of transactions in the stock market, short horizon forecasting is more interesting than long horizon especially for private investors. Therefore, selected forecasting horizon at current study is next five working days or next week.

Table 4. Results of Diagnostic Tests

| Period                         | Ljung-Box Serial-Correlation Q-statistic |                    |                             |                     |                     |                     |
|--------------------------------|------------------------------------------|--------------------|-----------------------------|---------------------|---------------------|---------------------|
|                                | 1                                        | 4                  | 8                           | 12                  | 16                  | 20                  |
| ARMA-EGARCH of Apple Co.       | 0.4802<br>(0.8412)                       | 7.7983<br>(0.0993) | 9.2436<br>(0.3228)          | 15.4101<br>(0.2204) | 15.6940<br>(0.7472) | 16.3742<br>(0.6935) |
| SETARMA-GARCH of Apple Co.     | 0.2598<br>(0.6103)                       | 7.0192<br>(0.1357) | 9.8292<br>(0.2771)          | 14.7282<br>(0.2572) | 16.3041<br>(0.4325) | 24.6610<br>(0.2158) |
| ARMA-EGARCH of Microsoft Co.   | 0.3459<br>(0.0865)                       | 2.8755<br>(0.1647) | 5.8679<br>(0.4384)          | 12.7249<br>(0.3872) | 18.2217<br>(0.6764) | 24.9422<br>(0.7461) |
| SETARMA-GARCH of Microsoft Co. | 0.9457<br>(0.0824)                       | 7.5344<br>(0.1664) | 17.1920<br>(0.2487)         | 25.5269<br>(0.3116) | 38.6218<br>(0.4233) | 53.7225<br>(0.5128) |
|                                | ARCH-Heteroscedasticity Test             |                    |                             |                     |                     |                     |
|                                | F-statistic                              |                    | Chi <sup>2</sup> -statistic |                     |                     |                     |
| ARMA-EGARCH of Apple Co.       | 0.0029<br>(0.9565)                       |                    | 0.0029<br>(0.9565)          |                     |                     |                     |
| SETARMA-GARCH of Apple Co.     | 0.0001<br>(0.9957)                       |                    | 0.0001<br>(0.9957)          |                     |                     |                     |
| ARMA-EGARCH of Microsoft Co.   | 0.058<br>(0.5682)                        |                    | 0.057<br>(0.5682)           |                     |                     |                     |
| SETARMA-GARCH of Microsoft Co. | 0.0062<br>(0.7451)                       |                    | 0.0062<br>(0.7451)          |                     |                     |                     |

**Note:** Reported Values in Parentheses Are Estimated Probabilities (Research Findings).

The specification of the developed ANN has reported in table (5). Five layer has considered for this network and MSE error criterion has employed in order to set the neurons weights. The gradient of error function will be reduced using Levenberg-Marquardt algorithm and the nonlinear activation function of Tangent-Sigmoid has assigned to the core of hidden layers every cell cores. Outcomes of simulations are depicted in figure (4).

**Table 5: The FF-BP network specifications**

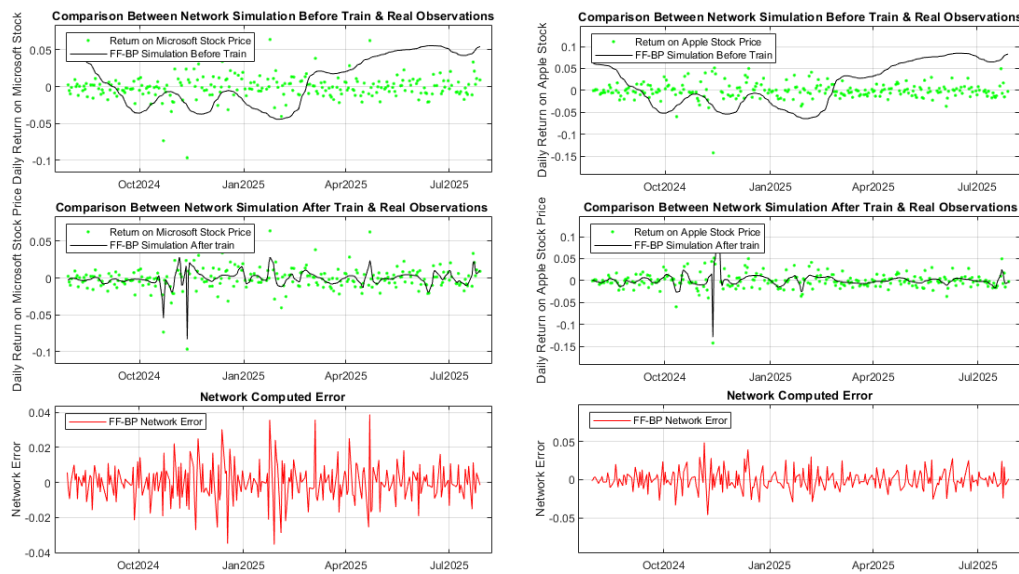
| Layers | Error Function | Activation Functions | Epochs | Topology       | Applied Algorithm | Training Goal |
|--------|----------------|----------------------|--------|----------------|-------------------|---------------|
| 5      | MSE            | Tangent-Sigmoid      | 100    | [1-15-30-15-1] | LM                | 1e-10         |

(Research Findings).

The first row of figure (4) consist of the network behavior before train, in which the neurons weights are randomly selected by the algorithm. The second row represents the behavior of the ANN after training and updating the stochastic initial weights. It can be observed that the network simulation process successfully captured the Data Generation Process (DGP) of the return series of the both companies. Networks error are figured in the third row, which due to the low values of the calculated errors, the accuracy of the developed networks in the simulation process can be comprehended. Results of in-sample prediction are tabulated at the following table. Comparison in-sample prediction of the developed models for Apple Corporation stock return time series based on MAPE criterion shows that the Exponential Smoothing (ES) method provided lower value than ARMA-EGARCH model and the regime-switching procedure. This finding implies higher accuracy of ES scheme than the other parametric methods of study.

Similarly, such outcome is again repeated based on bias proportion measurement and ES system exhibiting higher level of accuracy. In addition, the variance proportion criterion also indicates that the variation of simulated series by ES model is closer to the variation of the real return time series and the ARMA-EGARCH either SETAR-GARCH method generated higher levels of variation. Therefore, regardless of the RMSE criterion that endorsed the SETAR-GARCH model, the majority of error criteria explicitly recommended the exponential

smoothing model as the successful method of capturing the data generating process of the stock return series of Apple Corporation. Moreover, comparison between ARMA-EGARCH and SETAR-GARCH model representing higher level of precision of the regime switching model that it can caused by nonlinear structure of the men equation of SETAR approach.



**Fig. 4: Results of Artificial Neural Network Simulation (Research Findings).**

Findings about the Apple Corporation are repeated once more based on stock return of Microsoft Corporation, which in terms of all the prediction error criteria, the method of exponential smoothing exhibited higher level of accuracy compared to the other procedures. Nevertheless, comparison between the ES procedure and ANN approach reveals the outstanding performance of AI method. The developed FF-BF model represented the lower level of error in term of the all calculated criteria. Therefore, for the in-sample prediction, ANN model has outperformed the other methods of the current study. For the out of sample forecasting, the selected forecasting horizon is the next five working days. The reason for this short forecasting-horizon selection is reflected in the nature of the stock market, which is associated with the high speed of transactions and participants in this market are more concern about the short-horizon price and return fluctuations. Results of the out-sample forecasting are depicted in figure (5). Usually models that are successful

in capturing the DGP of a time series are expected to provide more accurate out-sample forecasting too.

**Table 6: Results of In-Sample Prediction**

| Model                          | RMSE          | MAPE          | BP              | VP              |
|--------------------------------|---------------|---------------|-----------------|-----------------|
| ARMA-EGARCH of Apple Co.       | 0.0395        | 103.6648      | 0.0006          | 0.7319          |
| SETARMA-GARCH of Apple Co.     | 0.0366        | 99.8985       | 0.0001          | 0.7586          |
| ETS-ES of Apple Co.            | 0.0376        | 64.8313       | 4.6E-07         | 6.5E-06         |
| MLP                            | <b>0.0001</b> | <b>13.629</b> | <b>1.02E-11</b> | <b>1.05E-13</b> |
| ARMA-EGARCH of Microsoft Co.   | 0.0311        | 98.0141       | 0.0002          | 0.9165          |
| SETARMA-GARCH of Microsoft Co. | 0.0281        | 97.4215       | 0.0008          | 0.8813          |
| ETS-ES of Microsoft Co.        | 0.0385        | 74.8522       | 2.5E-06         | 4.4E-05         |
| MLP                            | <b>0.0018</b> | <b>14.259</b> | <b>1.34E-11</b> | <b>1.11E-13</b> |

**Note:**  $\sigma E-\alpha$  is Equal to  $\sigma \times 10^{-\alpha}$   
(Research Findings).

As it is apparent from figure (5), the AI method has generated more close values to the real stock return time series of the both samples and vacillations are in line with the fluctuations of the real return series even compared to the exponential smoothing method. In contrast, the ARMA-EGARCH and SETAR-GARCH model have presented a linear out-sample forecasted values. Graphical comparison gives some insight about the accuracy of each model but is not sufficient, therefore error criteria were again computed and results are tabulated in table (7). The computed value of RMSE criterion of Apple Company for the ES model is lower than the regime switching and ARMA-EGARCH model, which implies that the accuracy of the exponential smoothing method compared to other two parametric methods are higher. Likewise, the calculated mean absolute percentage error criterion (MAPE) for the ES procedure is lower than the other two parametric models, which supports the result of the RMSE criterion about the precision of ES procedure. Likewise, the estimated bias proportion of the ES model is higher that is consist with the findings of the two previous criteria. Similarly, the results of variance proportion represent lower values for the exponential smoothing system in comparison with the ARMA-EGARCH and SETAR-GARCH model and implies that the mean and variance of

forecasted values by the ES system are closer to the mean and variance of the real stock return series. Yet again, when the results of the MLP is included in comparisons, the results are in favor of this procedure and accuracy of MLP once more is proved than the ES procedure so the other rival methods.

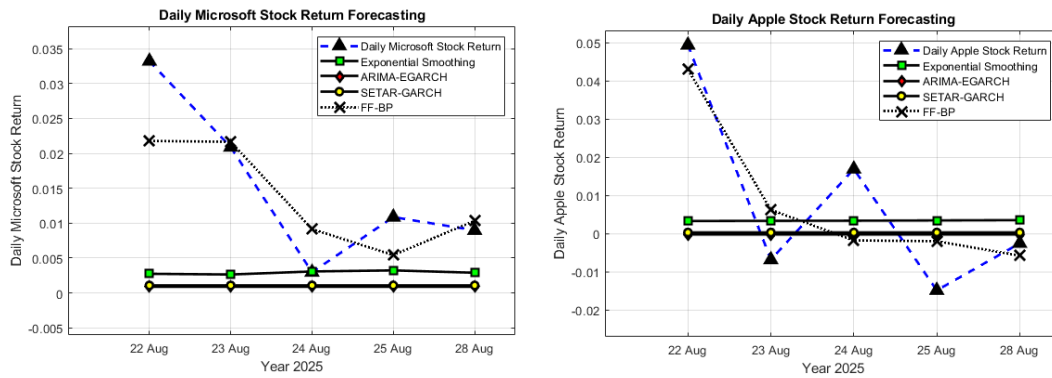


Fig. 5: Out-Sample Forecasting of Research Models (Research Findings).

Therefore, in the out-sample forecasting and based on all the computed error criteria, the MLP method has outperformed the Exponential Smoothing, ARMA-EGARCH and SETARMA-GARCH models in forecasting the Apple stock return series. This conclusion has reiterated by taking the Microsoft stock return forecasting into account. Meaning that, the MLP method has represented higher precision than the other methods of the present study. Furthermore, due to the nonlinear structure of SETAR-GARCH model, this method has outperformed the ARMA-EGARCH model based on the majority of error measurements in the both of selected time series. Findings of the current study are in line with outcomes of other researches such as [Khadiri et al., \(2025\)](#), [Gajdosikova & Michulek \(2025\)](#), [Zheng et al., \(2024\)](#), [Pattanayak & Swetapadma \(2024\)](#), [Audrey et al., \(2023\)](#), [Kurani et al., \(2023\)](#), [Hosseinidoust et al., \(2016\)](#).

A breakdown of why ANNs can be more accurate than the econometric models based on the previous studies are as follow. First, the econometric models often assume linear relationships between variables. However, real-world data, particularly financial data, frequently exhibits complex, non-linear patterns that ANNs are designed to model effectively, [Sameti et al., \(2011\)](#). Second, ANNs can learn and adapt to relationships in data without explicit assumptions about the functional form or the underlying data-generating process. This contrasts with

traditional econometric methods, which rely on specific theoretical or functional forms that might not accurately represent complex real-world phenomena, [Norouzian et al., \(2021\)](#). Third, trained neural networks act as experts in the data they have processed, enabling them to generalize information and learn complex mappings between inputs and outputs from examples, leading to improved predictive power, [Madanchi Zaj et al., \(2023\)](#). Fourth, in time-series data, such as stock market indices, ANNs can better approximate long-range dependencies, which are crucial for accurate forecasting but often difficult for traditional models to capture, [Xang et al., \(2018\)](#). Fifth, ANNs offer greater flexibility in modeling complex phenomena, such as volatility and asymmetry, which are common in financial markets and can lead to improved accuracy in volatility forecasts and risk management, [Sahiner et al., \(2023\)](#). Sixth, ANNs learn directly from data, adjusting their internal parameters through a process of training to minimize errors and optimize their ability to predict future outcomes based on observed patterns, [Ghiasi et al., \(2005\)](#).

**Table 7. Results of Out-Sample Forecasting**

| Model                          | RMSE   | MAPE     | BP     | VP     |
|--------------------------------|--------|----------|--------|--------|
| ARMA-EGARCH of Apple Co.       | 0.0063 | 87.3674  | 0.4244 | 0.5672 |
| SETARMA-GARCH of Apple Co.     | 0.0057 | 85.3088  | 0.2855 | 0.6789 |
| ETS-ES of Apple Co.            | 0.0020 | 71.6879  | 0.0303 | 0.0096 |
| MLP                            | 0.0001 | 24.5891  | 0.0015 | 0.0004 |
| ARMA-EGARCH of Microsoft Co.   | 0.0076 | 110.8361 | 0.2364 | 0.7608 |
| SETARMA-GARCH of Microsoft Co. | 0.0069 | 92.2591  | 0.1578 | 0.7898 |
| ETS-ES of Microsoft Co.        | 0.0013 | 70.2996  | 0.0551 | 0.0053 |
| MLP                            | 0.0002 | 29.5721  | 0.0019 | 0.0008 |

(Research Findings).

Lastly, in order to confirm that the suggested MLP method is truly more accurate than the ES model and the computed difference between the MLP procedure and the ES scheme are statistically significant, the Diebold and Mariano S-statistic is estimated. This test is based on the Squared Error (SE) loss function and for both of the in-sample and out-samples forecasting is computed. Results of this test are

reported in table (8). Recall that a negative and significant value of the S-statistic implying that the first model is dominant and more accurate than the second model. Paying attention to the calculated forecasting error criteria and higher performance of MLP method compared to the ES procedure and higher performance of MLP than the ES, Diebold-Mariano test is established based on MLP and ES procedure as the first and second model.

**Table 8: Results Diebold-Mariano Test**

| First Model | Second Model<br>Exponential Smoothing |
|-------------|---------------------------------------|
| MLP         | S-statistic for In-Sample Prediction  |
|             | -3.2381<br>(0.0287)                   |
| MLP         | S-statistic for Out-Sample Prediction |
|             | -2.0929<br>(0.04601)                  |

**Note:** Reported Values in Parentheses are Estimated Probabilities (Research Findings).

The computed S-statistic that is estimated based on errors of MLP procedure and ES model is negative and significant in the both in-sample and out-sample forecasting indicating that the developed Artificial Intelligence methods of MLP in the current study is significantly more accurate than the Exponential Smoothing model. In other words, the ability of MLP in determining and capturing the data generating process of the both return series is significantly higher than the other models.

## 5. Conclusion

Accurate stock market forecasting still has remained as a challenging and complex problem for the market analysts as well as the authorities and decision makers. Main objective of present research is to investigate the eligibility of nonlinear parametric and nonparametric models such as ARMA-EGARCH, SETARMA-GARCH, Exponential Smoothing and Multi-Layer Perceptron neural network as an Artificial Intelligence (AI) method. Data set consist of Apple and Microsoft daily stock return observations spanning from Aug 2024 to Auf 2025. Augmented Dickey-Fuller

(ADF) and Zivot-Andrews (ZA) stationary tests are employed to find the level of integration in the time series. Moreover, through the method of Terasvirta-Lin-Granger the nonlinearity of the data generating process is investigated to shed more light on chaotic behavior of the selected stock return series. The Self-Exciting Threshold Autoregressive Moving-Average (SETARMA) model is combined with GARCH-component that yields SETAR-GARCH and ARMA model combined with Exponential-GARCH model (ARMA-EGARCH) in order to capture the heterogeneous variance, which is a typical characteristic of the financial time series. All methods are checked using the relevant diagnostic tests such as normality, serial correlation and heteroscedasticity. Furthermore, both of in-sample and out-sample forecasting are carried out and the models performance is evaluated using the popular forecasting error criteria such as RMSE, MAPE, Bias Proportion and Variance Proportion. In addition, to determine significance of the observed difference between models the Diebold and Mariano test is employed to confirm selection of the best method. Findings indicate that the developed neural network (MLP) is outperformed the other methods for both of in-sample and out-sample forecasting in terms of majority of the calculated error criteria. Moreover, outstanding performance of the SETARMA-GARCH model has observed in comparison with the ARMA-EGARCH model. The computed S-statistic of Diebold-Mariano test confirmed results of the forecasting in favor of significant accurate performance of MLP method than the ES method. Findings of current study suggest application of dynamic nonlinear-nonparametric methods in modeling of stock return time series. The primary policy implication of Artificial Neural Network (ANN) models outperforming econometric models in forecasting is the potential for more informed and proactive policy-making by governments and businesses. This improved accuracy can lead to better decision-making, such as implementing timely economic interventions, managing resource allocation more effectively, and developing more robust risk management strategies in both public and private sectors. ANNs' ability to capture non-linear relationships in data, which econometric models often struggle with, allows for a deeper understanding of complex economic systems, supporting more effective responses to economic challenges.

## Acknowledgments

I would like to express my sincere gratitude to Prof. Fotros who contributed to the successful completion of this study. His dedication, expertise, and commitment was instrumental in the realization of this research objectives. I am thankful for his valuable insights, collaborative spirit, and unwavering support throughout this study.

## Observation Contribution

The corresponding author got the main observation contribution in present study.

## Conflict of Interest

All authors have participated in conception and design, or analysis and interpretation of the data; drafting the article or revising it critically for important intellectual content, and approval of the final version. The authors approved that there is no conflict of interest in publishing of the current study.

## References

- Adrian Cantemir Calin & Tiberiu Diaconescu & Oana – Cristina Popovici, (2014). “Nonlinear Models for Economic Forecasting Applications: An Evolutionary Discussion”. *Computational Methods in Social Sciences (CMSS)*, 2(1): 42-47. [https:// RePEc/ntu:ntcmss/1-14-042](https://RePEc/ntu:ntcmss/1-14-042).
- Awartani, B. & Corradi, V., (2005). “Predicting the Volatility of the S&P-500 Stock Index via GARCH Models: The Role of Asymmetries”. *International Journal of Forecasting*. 21(1): 167-183. <https://doi.org/10.1016/j.ijforecast.2004.08.003>.
- Bergman, M. & Hansson, J., (2005). “Real Exchange Rates and Switching Regimes”. *Journal of International Money and Finance*, 24(3): 121-138. <https://doi.org/10.1016/j.jimonfin.2004.10.002>.
- Bollerslev, T., (1986). “Generalized Autoregressive Conditional Heteroscedasticity”. *Journal of Econometrics*, 31(2): 307-327. [https://doi.org/10.1016/0304-4076\(86\)90063-1](https://doi.org/10.1016/0304-4076(86)90063-1).

- Bowerman, B. L. & Richard T. O., (1979). *Time Series and Forecasting: An Applied Approach*. University of Michigan, New York: Duxbury Press.
- Box, G. & Jenkins, G., (1970). *Time Series Analysis: Forecasting and Control*. San Francisco: Holden-Day Pub.
- Bradfield, J., (2007). *Introduction to the Economics of Financial Markets*. Oxford University Press.
- Brooks, C., (2008). *Introductory to Econometric for Finance*. The ICMA Centre, University of Reading, 2<sup>nd</sup> Edition. Cambridge University Press.
- Calin, A. C., Diaconescu, T. & Popovici, O. C., (2014). “Nonlinear Models for Economic Forecasting Applications: An Evolutionary Discuss”. *CMSS*, 2(1).
- Clements, M. P. & Smith, J., (1999). “A Monte Carlo Study of the Forecasting Performance of Empirical SETAR Models”. *Journal of Applied Econometrics*, 14(2): 123-141. [https://doi.org/10.1002/\(SICI\)1099-1255\(199903/04\)14\(2\):123-141](https://doi.org/10.1002/(SICI)1099-1255(199903/04)14(2):123-141).
- De Gooijer J. G. & Kumar, K., (1992). “Some Recent Development in Non-Linear Time Series Modeling, Testing and Forecasting”. *International Journal of Forecasting*, 8(2): 135-156. [https://doi.org/10.1016/0169-2070\(92\)90115-P](https://doi.org/10.1016/0169-2070(92)90115-P).
- Dickey, D. A. & Fuller, W. A., (1979). “Distribution of the Estimators for Autoregressive Time Series with a Unit Root”. *Journal of the American Statistical Association*, 74(366): 427-431. <https://doi.org/10.2307/2286348>.
- Diebold, F. & Mariano, R., (1995). “Comparing Predictive Accuracy”. *Journal of Business and Economic Statistics*, 13(3): 253-263. <https://doi.org/10.2307/1392185>
- Engel. C., (1994). “Can the Markov Switching Model Forecast Exchange Rates”. *Journal of International Economics*, 36(1): 151–165. [https://doi.org/10.1016/0022-1996\(94\)90062-0](https://doi.org/10.1016/0022-1996(94)90062-0).
- Engle, R. F., (1982). “Autoregressive Conditional Heteroscedasticity with Estimate of the Variance of the United Kingdom Inflation”. *Econometrica*, 50(4): 987-1007. <https://doi.org/10.2307/1912773>.
- Engle, R. F., Lilien, D.M. & Robbins, R. P., (1987). “Estimating Time Varying Risk Premia in the Term Structure: The ARCH-M Model”. *Econometrica*, 55(2): 391-407. <https://doi.org/10.2307/1913242>.

- Faria, E. L., Albuquerque, M. P., Gonzalez, J. L., Cavalcante, J. T. P. & Albuquerque, M., (2009). "Predicting the Brazillian Stock Market through Neural Networks and Adaptive Exponential Smoothing Methods". *Expert Systems with Applications*, 36(10): 12506-12509. <https://doi.org/10.1016/j.eswa.2009.04.032>.
- Gajdosikova, D., Michulek, J. & Tulyakova, I., (2025). "AI-Based Bankruptcy Prediction for Agricultural Firms in Central and Eastern Europe". *International Journal of Financial Studies*, 13(3): 1-35. <https://doi.org/10.3390/ijfs13030133>.
- Hosseinidoust, S. E., Fotros, M. H., & Massahi, S., (2016). "Application of Dynamic Parametric and Non-Parametric Systems in Stock Market Return Forecasting: Case Study of Tehran Stock Market". *Quarterly Journal of Fiscal and Economic Policies*, 3(12): 125-148. <http://qjefp.ir/article-1-289-en.html> . (In Persian)
- Hyndman, R. J., Koehler, A. B., Snyder, R. D. & Grose, S., (2002). "A State Space Frame-work For Automatic Forecasting Using Exponential Smoothing Methods". *International Journal of Forecasting*, 18(3): 439-454. [https://doi.org/10.1016/S0169-2070\(01\)00110-8](https://doi.org/10.1016/S0169-2070(01)00110-8).
- Jin, B., & Xu, X., (2025). "Predictions of Residential Property Price Indices for China via Machine Learning Models". *Quality & Quantity: International Journal of Methodology*, 59(2): 1481-1513. <https://doi.org/10.1007/s11135-025-02080-3>.
- Khadiri, H., Oukhouya, H. & Belkhoutout, K., (2025). "A comparative Study of Hybrid and Individual Models for Predicting the Moroccan MASI Index: Integrating Machine Learning and Deep Learning Approaches". *Scientific African*, 28(2). <https://doi.org/10.1016/j.sciaf.2025.e02671>.
- Kurani, A., Doshi, P., Vakharia, A. & Shah, M., (2023). "A Comprehensive Comparative Study of Artificial Neural Network (ANN) and Support Vector Machines (SVM) on Stock Forecasting". *Annals of Data Science*, 10(1): 183-208. <https://doi.org/10.1007/s40745-021-00344-x>.
- Leung, M. T., Daouk, H. & Chen, A. S., (2000). "Forecasting Stock Indices: A Comparison of Classification and Level Estimation Models". *International Journal of Forecasting*, 16(2): 173-190. <http://dx.doi.org/10.2139/ssrn.200429>.

- Moha Tahir Ismail, Z. I., (2006). "Modeling Exchange Rate Using Regime Switching Models". *Sains Malaysiana*, 35(2): 55-62.  
<https://www.researchgate.net/publication/232275538>.
- Pattanayak, A. M., Swetapadma, A. & Sahoo, B., (2024). "Exploring Different Dynamics of Recurrent Neural Network Methods for Stock Market Prediction - A Comparative Study". *Applied Artificial Intelligence*, 38(1).  
<https://doi.org/10.1080/08839514.2024.2371706>.
- Peel, D. A. & Speight, A. E. H., (1998). "Threshold Nonlinearities in Output: Some International Evidence". *Applied Economics*, 30(3): 323–333.  
<https://doi.org/10.1080/000368498325840>.
- Potter, S. M., (1995). "A Nonlinear Approach to US GNP". *Journal of Applied Econometrics*, 10(2): 109–125. <http://www.jstor.org/stable/2284968>.
- Song, D. & Song, D., (2024). "Stock Price Prediction based on Time Series Model and Long Short-term Memory Method". *Highlights Business, Econ. Manage*, 24(3): 1203-1210. <https://doi.org/10.54097/e75xgk49>.
- Terasvirta, T, C. L. & Granger, C., (1993). "Power of the Neural Network Linearity Test". *Journal of Time Series Analysis*, 14(2): 209:220.  
<https://doi.org/10.1111/j.1467-9892.1993.tb00139.x>.
- Terence Tai-Leung, Ch., Lam, T.-H. & Hinich, M. J., (2009). "Are Nonlinear Trading Rules Profitable In The Chinese Stock Market?". *Annals of Financial Economics (AFE)*, World Scientific Publishing Co. Pte. Ltd., 5(01): 1-20.  
<https://doi.org/10.1142/S201049520950002X>.
- Tong, H., (1978). "On a Threshold Model in Pattern Recognition and Signal Processing". In: Chen, C., Ed., *Pattern Recognition and Signal Processing*, Sijhoff and Noordhoff, Amsterdam, 55(4): 575-586.  
<https://www.researchgate.net/publication/246995827>.
- Tong, H., (1983). *Threshold Models in Non-Linear Time Series Analysis*. Springer: New York. <https://link.springer.com/book/10.1007/978-1-4684-7888-4>
- Tong, H. & Lim, K. S., (1980). "Threshold Autoregression, Limit Cycles and Cyclical Data". *Journal of the Royal Statistical Society. Series B (Methodological)*, 42(3): 245–292. <http://www.jstor.org/stable/2985164>.

- Tripathi, A., Harekrishna, P. D., Sanikumar, S., Parmar, S. & Upadhyaya, D., (2025). "Advanced Stock Market Prediction using Conv-LSTM with Genetic Algorithm Optimization and Market Sentiment Integration". *Grenze International Journal of Engineering & Technology (GIJET)*, 8(1): 5-24. <https://doi.org/10.48550/arXiv.2505.05325>.
- Wang, P., (2008). *Financial Econometrics*. Taylor & Francis. Routledge Press. <https://doi.org/10.4324/9780203892879>.
- Zakhidov, G., (2024). "Economic Indicators: Tools for Analyzing Market Trends and Predicting Future Performance". *International Multidisciplinary Journal of Universal Scientific Prospective*, 2(3): 23-29. <https://www.scirp.org/reference/referencespapers?referenceid=3897171>.
- Zheng, H., Wu, J., Song, R., Guo, L. & Xu, Z., (2024). "Predicting Financial Enterprise Stocks and Economic Data Trends Using Machine Learning Time Series Analysis". *Applied and Computational Engineering*, 87(1): 26-32. <https://doi.org/10.54254/2755-2721/87/20241562>.
- Zivot, E. & Andrews, D. W. K., (1992). "Further Evidence on the Great Crash the Oil-Price Shock and the Unit-Root Hypothesis". *Journal of Business and Economic Statistics*, 10(3): 51:70. <https://doi.org/10.2307/1391541>.



**فصلنامه علمی مطالعات اقتصادی کاربردی ایران**  
 چاپی: ۲۵۲۰-۲۳۲۲؛ چاپی الکترونیکی: ۴۷۲۸-۲۳۲۲ - وبسایت نشریه: <https://aes.basu.ac.ir>  
 نشریه گروه اقتصاد، دانشکده علوم اقتصادی و علوم اجتماعی، دانشگاه بوعلی سینا، همدان، ایران.  
 حق انتشار این مستند، متعلق به نویسنده(گان) آن است. ۱۴۰۴ - ناشر این مقاله، دانشگاه بوعلی سینا است.  
 این مقاله تحت گواهی زیر منتشر شده و هر نوع استفاده غیرتجاری از آن مشروط بر استناد صحیح به مقاله و با رعایت شرایط مندرج در آدرس زیر مجاز است.  
 Creative Commons Attribution-NonCommercial 4.0 International license (<https://creativecommons.org/licenses/by-nc/4.0/>).



## پیش بینی بازده سهام با استفاده از روش های غیرخطی پویا: مدل سازی پارامتریک و ناپارامتریک

سید احسان حسینی دوست<sup>۱</sup>، محمد حسن فطرس<sup>۲</sup>

نوع مقاله: پژوهشی

شناسه دیجیتال: <https://doi.org/10.22084/aes.2025.31371.3815>

تاریخ دریافت: ۱۴۰۴/۰۵/۱۲، تاریخ بازنگری: ۱۴۰۴/۰۶/۰۱، تاریخ پذیرش: ۱۴۰۴/۰۶/۰۹

صص: ۱۵۱-۱۲۱

### چکیده

پیش بینی دقیق بازار سهام یک مسئله چالش برانگیز و پیچیده برای تحلیلگران و تصمیم گیرندگان بازار است. در اغلب مطالعات گذشته، دقت روش های مختلف مورد بررسی قرار گرفته است، اما هنوز در مورد روش پیش بینی بهینه اتفاق نظر وجود ندارد. هدف اصلی مطالعه حاضر بررسی قابلیت مدل های سری های زمانی غیرخطی، مانند مدل های هموارسازی نمایی و رویکرد تغییر رژیم، در کنار روش باکس-جنکینز در پیش بینی بازده سهام است. داده ها شامل مشاهدات روزانه شرکت های اپل و مایکروسافت از سال ۲۰۲۴ تا ۲۰۲۵ م. است. آزمون تراسوریتا-لین-گرنجر رفتار آشوبناک فرآیند تولید داده ها را به اثبات رسانده است. رویکرد SETAR با مؤلفه GARCH و مدل ARMA با مؤلفه EGARCH برای کنترل اثر واریانس ناهمسان شرطی در سری های زمانی استفاده شده است که منجر به مدل های ترکیبی پویا می شود. علاوه بر این، با توجه به کاربرد گسترده روش های هوش مصنوعی، علاوه بر رویکرد هموارسازی نمایی (ES) به عنوان یک روش ناپارامتریک، یک شبکه پرسپترون چندلایه (MLP) نیز مورد استفاده قرار گرفته است که مبتنی بر الگوریتم پس انتشار خطا (FF-BP) است. پیش بینی ها در دو فرم درون نمونه ای و برون نمونه ای انجام شده و عملکرد مدل ها با استفاده از معیارهای خطای استاندارد ارزیابی می شود. در نهایت، از آزمون دایبولد-ماریانو برای تعیین معناداری تفاوت های پیش بینی بین مدل ها استفاده شده است. یافته ها نشان می دهند که سری های زمانی بازده سهام هر دو شرکت رفتاری آشوبناک داشته اند و روش های غیرخطی در مدل سازی آن ها مناسب تر هستند. روش هموارسازی نمایی از نظر اکثر معیارهای خطا در هر دو پیش بینی درون نمونه ای و برون نمونه ای، از مدل های SETARMA-GARCH و ARMA-EGARCH بهتر عمل کرده است. با این حال، روش MLP براساس تمامی معیارهای خطا، بر مدل ES برتری داشته است. آماره S تخمینی آزمون دایبولد-ماریانو، معناداری برتری رویکرد MLP را تأیید می نماید. این یافته ها، استفاده از روش های ناپارامتریک پویا را در مدل سازی و پیش بینی سری های زمانی منتخب پیشنهاد می کند؛ به عبارت دیگر، استفاده از روش های غیرخطی ناپارامتریک پویا در پیش بینی سری های مالی توصیه می شود.

**کلیدواژگان:** پیش بینی بازده سهام، آزمون آشوب، روش های پارامتریک و ناپارامتریک، مدل سازی غیرخطی پویا، مدل هوش مصنوعی.

**طبقه بندی JEL:** G11, G14, G17, G32.

۱. استادیار گروه اقتصاد، دانشکده علوم اقتصادی و اجتماعی، دانشگاه بوعلی سینا، همدان، ایران (نویسنده مسئول).

Email: [hosseindoust@basu.ac.ir](mailto:hosseindoust@basu.ac.ir)

۲. استاد گروه اقتصاد، دانشکده علوم اقتصادی و اجتماعی، دانشگاه بوعلی سینا، همدان، ایران.

Email: [fotros@basu.ac.ir](mailto:fotros@basu.ac.ir)



**Applied Economics Studies, Iran (AESI)**P. ISSN:2322-2530 & E. ISSN: 2322-472X - Journal Homepage: <https://aes.basu.ac.ir/>

Scientific Journal of Department of Economics, Faculty of Economic and Social Sciences, Bu-Ali Sina University, Hamadan, Iran. Owner &amp; Publisher: Bu-Ali Sina University.

© Copyright © 2025 The Authors. Published by Bu-Ali Sina University.

This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International license (<https://creativecommons.org/licenses/by-nc/4.0/>). Non-commercial uses of the work are permitted, provided the original work is properly cited.

## The Interactive Effect of Property Rights and Research & Development on Total Factor Productivity

Abolfazl Shahabadi<sup>1</sup> , Maede Torkamani<sup>2</sup> 

Type of Article: Research

 <https://doi.org/10.22084/aes.2025.31417.3819>

Received: 2025/08/16; Revised: 2025/09/13; Accepted: 2025/09/16

Pp: 153-181

### Abstract

Total factor productivity (TFP) is a pivotal determinant of sustained economic growth, serving as a measure of how efficiently inputs are transformed into output. Elevating TFP is not just a technical goal but a strategic necessity for nations aiming to achieve enduring prosperity and bolster their global competitiveness. This study analyzes the influence of key factors—including domestic R&D accumulation, R&D spillovers via imports, human capital, property rights, and economic freedom—on TFP in selected developing countries between 2011 to 2022. The findings indicate that while domestic R&D accumulation alone yields a positive but statistically insignificant effect on TFP, other variables such as R&D spillovers, property rights, and economic freedom have significant and positive impacts. Importantly, the interplay between strong property rights and domestic R&D acts as a potent driver of productivity gains. These insights suggest that policymakers should not only support innovation and research efforts but also cultivate institutional environments that protect property rights and promote economic liberalization. Such a holistic approach is essential for maximizing productivity, fostering sustainable development, and enhancing a nation's position on the world stage. By understanding and leveraging these mechanisms, developing countries can unlock greater economic potential and chart a path toward long-term growth.

**Keywords:** Property Rights, Economic Freedom, R & D, R & D Spillovers, Human Capital.

**JEL Classification:** O32, J24, D24.

1. Professor, Department of Economics, Faculty of Social Science and Economics, Alzahra University, Tehran, Iran. (Corresponding Author).

**Email:** [a.shahabadi@alzahra.ac.ir](mailto:a.shahabadi@alzahra.ac.ir)

2. M.A in Economics, Department of Economics, Faculty of Social Science and Economics, Alzahra University, Tehran, Iran.

**Citations:** Shahabadi, A. & Torkamani, M., (2025). "The Interactive Effect of Property Rights and Research & Development on Total Factor Productivity". *Journal of Applied Economics Studies in Iran*, 14(55): 153-181. <https://doi.org/10.22084/aes.2025.31417.3819>

**Homepage of this Article:** [https://aes.basu.ac.ir/article\\_6256.html?lang=en](https://aes.basu.ac.ir/article_6256.html?lang=en)

## 1. Introduction

Total factor productivity (TFP) is widely recognized as the main driver of long-term economic growth, and it measures how efficiently economies convert inputs such as capital and labor into outputs. In addition to reflecting technological progress, the TFP represents an improvement in the quality of the institution, its innovation capacity and its efficiency in allocating resources (Gollin, 2002; Hall & Jones, 1999). Strengthening the TFP is not only essential for sustainable economic development, but also crucial to improving international competitiveness and social well-being, especially in developing countries where input-led growth models are increasingly constrained by resource constraints and diminishing returns (Aghion *et al.*, 2019; Syverson, 2011).

Despite its importance, TFP growth has remained slow in many developing economies, prompting renewed academic and political interest in identifying key determinants of total factor productivity. A growing body of literature points to the central role of knowledge factors - such as domestic accumulation of R&D, external R&D spillovers via trade and investment, and human capital - as the key drivers of productivity growth (Griliches, 1992; Coe and Helpman, 1995; Kumar and Siddhartha, 2015). In addition to these technological drivers, institutional factors - including protection of property rights and economic freedom - are increasingly being highlighted as key enablers that shape incentives for innovation, reduce transaction costs and support efficient market functioning (Acemoglu and Robinson, 2012; Gwartney *et al.*, 2023). Recent empirical studies further confirm that the interaction between technological skills and institutional quality have a significant impact on productivity performance in different countries (Habib *et al.*, 2019; Pegkas *et al.*, 2020; Markowska-Przybyla, 2020).

However, although these variables have been studied separately or in combination, there is still a significant gap in the literature as to their combined and interactive effects on TFP, especially in the context of emerging economies undergoing structural change. Most existing studies focus either on technological determinants (e.g. Li *et al.*, 2024; Pan *et al.*, 2022) or institutional frameworks (e.g. Zourki and Taherinia, 1403), but rarely integrate both dimensions in a single analytical framework. Moreover, few studies systematically assess how institutional enablers such as economic freedom and property rights dampen the effectiveness of knowledge inputs such as research and development and human capital in increasing productivity (Norouzi *et al.*, 1,400; Shahabadi, 2003).

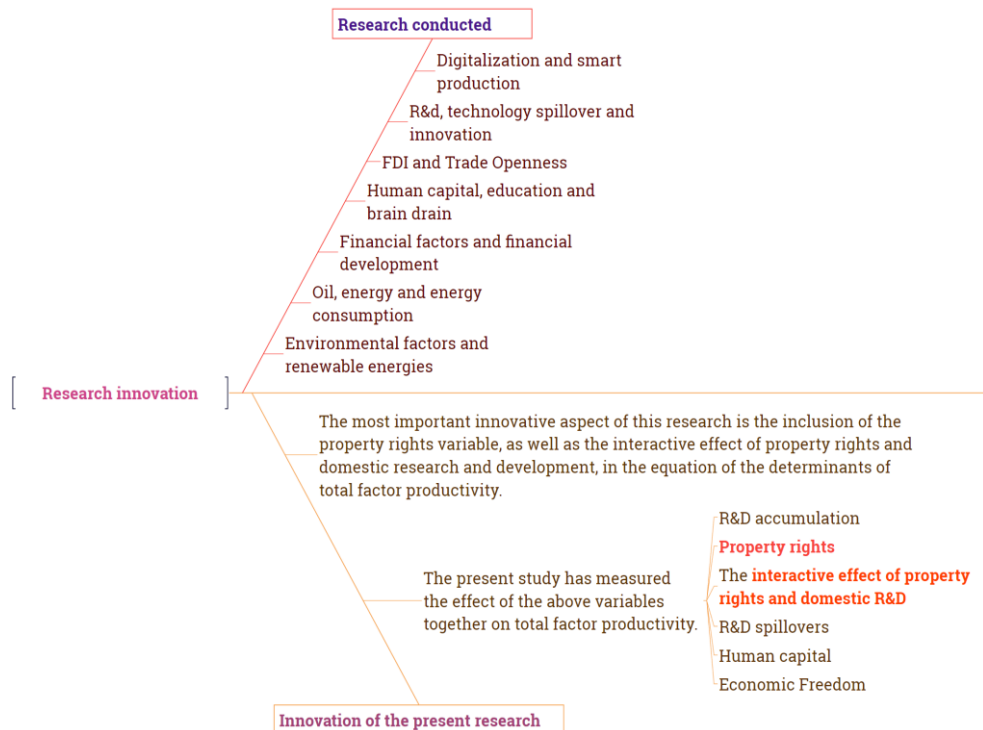
This study addresses this critical research gap by providing a comprehensive analysis of the combined and conditional effects of domestic accumulation of R&D, import-led R&D spillovers, human capital, property rights and economic freedom on total factor productivity in a panel of developing countries from 2011 to 2022. By modelling both

technological and institutional determinants simultaneously and exploring the potential interactions, this research provides a more nuanced understanding of the mechanism for productivity gains. The findings not only contribute to theoretical discussions about the institutional and technological links in the process of growth, but also provide practical insights for policy makers in designing integrated strategies that combine innovation policies with institutional reforms to accelerate productivity growth and economic convergence.

It should be noted that a number of studies have examined determinants of total factor productivity (TFP), focusing on variables such as digitization and smart manufacturing, technological and innovation spillovers, FDI and trade openness, human capital and migration, financial development, energy resources, governance and institutional quality.

No comprehensive study has been found to assess at the same time the impact of key knowledge variables such as domestic R&D accumulation, R&D spillovers and human capital, together with the contribution of enabling institutional factors such as economic freedom and property rights, on total factor productivity (TFP).

Figure 1, in the form of a graph, clearly illustrates the innovative aspect of this study compared with other studies carried out on total factor productivity.



**Fig. 1: The innovative aspect of the present study compared to other research conducted in the field of total factor productivity.**

The structure of the article is as follows: the second section presents the theoretical basis and explains the mechanism by which explanatory variables influence dependent variables. Part three presents the research background, part four presents statistical evidence, part five presents the research model and methodology, part six assesses the model and analyses the results, and part seven summarizes and presents policy recommendations.

## 2. Theoretical foundations

Before Solow's growth theory was developed in the 1960s, economists largely attributed economic growth to traditional factors of production, such as labor, physical capital, and land. But [Robert Solow \(1960\)](#) showed that a large part of economic growth can be explained by residual factors--that is, factors other than labor and physical capital. In his model, Solow treated total factor productivity (TFP) as a time-dependent variable and assumed that it was an exogenous variable.

Subsequent economists, in particular Paul Romer and others, have challenged this view by identifying the specific determinants of the TFP. Contemporary theories of growth stress the critical role of the knowledge components in driving productivity. Factors such as domestic accumulation of R&D, international knowledge and technology spillovers and human capital are now seen as integral components of modern productive functions.

Moreover, institutional variables such as economic freedom and property rights are key enablers for productive activity. These factors influence TFP both directly - by shaping incentives and allocation of resources - and indirectly - by increasing the absorptive capacity of economies and stimulating innovation.

Domestic R&D accumulation is closely linked to overall factor productivity growth (TFP). Research and development activities drive technological progress, improving the efficiency and output of manufacturing processes. These activities stimulate innovation and lead to the creation of advanced machines and equipment, helping to accelerate and optimize production, reduce transaction costs and ultimately contribute to the increase of the TPD. In addition, research and development enhance knowledge spillovers, which play an essential role in increasing productivity. Innovations developed through R&D can be taken up and used by other companies and sectors, thus spreading their positive effects to the wider economy ([Herzer, 2022](#)).

However, under certain conditions domestic R&D can have a negative impact on TFP. For example, overinvestment in applied research to the detriment of basic research may impede long-term productivity gains. The potential for breakthrough innovations to drive sustainable growth in TFP may be limited by a disproportionate focus on short-term,

incremental improvements ([Axquitt & Oates, 2021](#)). This risk is particularly acute when R&D is carried out only under government mandates and is not linked to market mechanisms. Conversely, R&D initiatives that respond to societal needs and market demand - whether led by the public or private sector - are more likely to produce positive productivity outcomes.

Moreover, the omission of complementary investment may undermine the effectiveness of research and development. Without sufficient investment in areas such as training of workers, management practices and infrastructure, research and development alone may not translate into productivity gains ([Graman \*et al.\*, 2005](#)).

Another challenge arises from knowledge spillovers to competitors. If domestic innovations are easily replicated by foreign firms-due to weak intellectual property enforcement or high labor mobility-the originating country may not fully capture the productivity benefits ([Jaffee & Lerner, 2011](#)).

In summary, while domestic R&D has the potential to significantly improve TFP, its efficiency depends on strategic planning, on responding to market and societal needs, and on having the right complementarities in place. Misguided R&D policies or misdirected investment may not only fail to improve productivity, but can also have negative consequences.

Property rights are an important factor in creating a competitive environment in the field of economic activities that allows a large number of people and economic activists to operate. In today's world, there are two types of order. On one side, there are societies with a limited access order, in which some people, under the guise of sovereignty or connected to sovereignty, create rent by creating a monopoly and limiting the entry of others into the field of management of political and economic systems. On the other side, there is an open access order that paves the way for individuals to enter the field of free economic and political competition. In such systems, free competition determines the level of access of individuals to the resources of the society. Therefore, governments that seek to establish an open access order pay more special attention to one of the most fundamental components of this structure, which is property rights. Because property rights play a key role in the formation of a healthy and sustainable competitive environment. Because property rights prevent fraud and, on the other hand, ensure the rule of law in society ([North \*et al.\*, 2009](#)). It is noteworthy that in both types of governments with open access and limited access, property rights are relatively respected, but the difference between the two types of governance is that in the open access type, property rights belong to the majority of the people in the society, but in the limited access type, property rights are respected only by a

certain number of people in the society. In a society where free and equal access is provided, people are more motivated and enthusiastic to develop their latent talents. Such an environment encourages them to spend their energy on increasing their knowledge and skills instead of relying on special privileges and rent-seeking. As a result, society will witness the formation of a capable and specialized force that plays an important role in promoting productivity and the prosperity of production. However, in contrast, governments that restrict access to resources and opportunities reduce the motivation of individuals to actively participate in the economic and political arenas and pave the way for increased rent-seeking. These restrictions not only reduce healthy competition, but also contribute to resource scarcity. Because, as mentioned, the lack of open access prevents the development of talents, the growth of technology, and the advancement of research and development. Since the increase in production productivity depends on the creation of acquired advantages in the economy, limited access will directly disrupt the growth of productivity by creating a shortage of resources. Regarding the impact of property rights on the growth of productivity of all factors of production, it is necessary to pay attention to all aspects of property rights in a balanced manner. If a government pays more attention to one type of intellectual property rights or physical property rights than necessary and neglects the other, productivity growth will be slower. Especially in today's technology-hungry world, it is necessary to pay special attention to intellectual property rights.

Property rights play an important role in enhancing total factor productivity growth by creating an environment for innovation, investment, and efficient allocation of resources. Very high of property rights, especially intellectual property rights (IPRs), encourage individuals and organizations to invest in research and development. Because by ensuring that innovators can benefit from their creativity and inventions, property rights reduce the risk of imitation and promote technological advances (Habib *et al.*, 2019). Intellectual property rights provide protection for innovations and inventions. Of course, it is important to note that property rights should be respected by both the innovator and the user of the innovation in order to maximize its positive impact on the productivity of factors of production. Also, when property rights are well defined and enforced, meaning that there is open and maximum access in society, resources are allocated to their most productive uses and the efficient allocation of resources is effectively promoted (Habib *et al.*, 2019). Property rights create a fertile environment for economic activities, as property rights create a framework in which businesses can operate without fear of expropriation or unfair competition. This environment supports economic growth and the development of high-quality companies (Zhu and Sun, 2023).

The interactive effect of property rights and domestic R&D: Strong protection of property rights and expansion of R&D activities are both important drivers of productivity growth, but their interaction can strengthen or moderate their individual effects. Since the relationship between property rights and domestic R&D is a complementary relationship, the consensus of these two variables will lead to the formation of a positive interaction between these two variables, which will be beneficial for the growth of factor productivity. Also, the existence of a high score in patent rights increases the productivity gains from R&D, especially in technology-based sectors (Park and Ginart, 1997). On the other hand, if a positive interaction between property rights and domestic R&D does not form, its effect on total factor productivity growth will be weakened. For example, in weak institutional environments where property rights are weakly and ineffectively enforced, R&D may not lead to TFP growth because it reduces the incentive to engage in R&D (Ajomoglu *et al.*, 2006). Notably, the productivity benefits of R&D are significantly higher in countries with strong legal systems that protect intellectual and physical property (Falvey *et al.*, 2006). Conversely, in countries with weak and limited property rights, R&D may lead to rent-seeking rather than innovation, reducing its productivity impact (Murphy *et al.*, 1993). Thus, the way in which property rights and domestic R&D interact will be influential in their impact on TFP growth.

R&D spillovers: Countries indirectly gain access to the R&D achievements of their trading partners by importing goods and services—especially intermediate and capital goods—from their trading partners. This process operates through two main pathways: first, through learning and imitation of new technologies, which allows for the localization and improvement of domestic production processes; and second, through the use of higher-quality inputs (such as advanced machinery and raw materials) that increase production efficiency (Coe *et al.*, 2009). The higher the share of imports in a country's GDP (the higher the economy's sophistication), the greater its exposure to global advanced technologies and, consequently, the greater its absorption of foreign R&D benefits. R&D activities produce knowledge that can be shared and used by other firms and industries. These knowledge spillovers contribute to the growth of TFP by enabling firms to adopt best practices, improve processes, and innovate (Spittoven and Merloyd, 2023). In addition, the import of high-tech goods acts as a vital conduit for knowledge transfer and contributes to the growth of total factor productivity (TFP) (Blitz and Molders, 2013). If the results of foreign R&D spillovers enter a country in a way that is not in line with the needs of that country, it can lead to misallocation of resources in a direction that is not beneficial to the country's economy and thus cause a waste of resources, which in turn will have a negative

impact on the growth of total factor productivity. Of course, R&D spillovers do not inherently have a negative impact on the productivity of production factors in the economy of countries, but if the import of technology is not in line with the economic structure of the importing country (i.e., it is not in line with its needs for user-, capital-, or knowledge-intensive technology), it cannot be expected that this type of R&D will lead to an increase in total factor productivity. Planning and directing R&D spillovers in the country should be in a way that complements domestic R&D and, on the other hand, is in line with the needs of the importing country's industry and economy in order to improve total factor productivity.

Human capital increases the ability of workers to innovate and adopt new technologies, which in turn strengthens TFP ([Kijak, 2020](#)). Human capital can complement research and development activities and lead to innovation in equipment and production processes, which will have a positive effect on the growth of total factor productivity. Of course, human capital can also have different effects on productivity depending on the type of economic structure of countries. In developed economies, where the capacity of human capital is used in a desirable and targeted manner, it will have significant effects on the growth of factor productivity and, consequently, economic growth. However, in developing economies, due to the lack of appropriate space for the demand for human capital by the government or enterprises, human capital not only does not increase the productivity of production factors, but also reduces the productivity of factors in other sectors of the economy due to the high costs incurred for the growth of this factor in the country and the lack of its application in the economy to generate wealth and income. Therefore, although human capital is effective in productivity growth, the role of the quality of governance and scientific management at the level of macro policy-making and economic development of countries is very decisive in maximizing the impact of human capital on the productivity of production factors.

**Economic Freedom:** According to the definition of the [Heritage Foundation \(2025\)](#), economic freedom is a fundamental right of every individual to control his or her own work and property. In an economically free society, individuals are free to engage in various activities, including work, production, consumption, and investment, without restriction. In such societies, governments facilitate the free movement of labor, capital, and goods, and avoid unnecessary restrictions that might infringe on economic freedoms. Their goal is to protect economic freedom without overly restricting it.

Economic freedom affects factor productivity growth through the allocation of resources and the creation of innovation and entrepreneurship. Economic freedom allows

for a more efficient allocation of resources, which increases productivity. When businesses operate in an environment with less burdensome regulations and less disincentive taxes, they can allocate resources more efficiently, leading to higher TFP. Economic freedom also fosters innovation and entrepreneurship, which are key drivers of TFP. A favorable business environment encourages firms to invest in new technologies and innovative practices, which lead to increased factor productivity (Bjornskov *et al.*, 2010). Economic freedom also affects total factor productivity growth through the channel of institutional quality. High levels of economic freedom are often associated with strong institutions that protect property rights and enforce contracts properly. These institutions create a stable environment for businesses to operate, reduce uncertainty, and promote long-term investments in productivity-enhancing activities (Borowicz *et al.*, 2020). While economic freedom is generally associated with positive economic outcomes, it can sometimes have a negative impact on total factor productivity (TFP) growth under certain circumstances. One of the issues that can lead to the negative effect of economic freedom on total factor productivity is weak institutional frameworks, which are mainly observed in developing countries. In countries with weak institutions, increased economic freedom may lead to regulatory capture or corruption. This can distort resource allocation and reduce productivity growth (Erdem and Toksu, 2012). In fact, it is noted that to benefit from the positive effects of economic freedom on productivity growth, countries should apply it in proportion to their level of development and institutional quality. In this case, they will be able to gain new comparative advantages. In this situation, the growth of total factor productivity in countries will reduce the gap between developed and developing countries in this regard. This is the goal that economic freedom pursues in order to increase total factor productivity. Otherwise, what is expected from the impact of this variable on total factor productivity will not happen.

### 3. Research Background

The existing literature on total factor productivity (TFP) offers a comprehensive and multi-dimensional understanding of the drivers influencing productivity growth across different economic contexts. A significant body of research emphasizes the transformative role of digitalization and smart manufacturing in enhancing TFP. For instance, Liu and Zhuo (2025), Li *et al.*, (2024), and Cheng *et al.*, (2023) consistently highlight that digital transformation and smart manufacturing policies significantly boost TFP in China by improving industrial chain integration, flexibility, and innovation capacity. These findings are further reinforced by Pan *et al.*, (2022), who identify a positive nonlinear relationship

between the digital economy and provincial TFP, suggesting that digitalization not only drives immediate efficiency gains but also supports long-term sustainable productivity growth. Compared to earlier studies focusing on traditional inputs, these recent works underscore a paradigm shift toward technology-driven productivity, positioning digital infrastructure as a core production factor rather than a supplementary tool.

Another prominent theme revolves around innovation and knowledge accumulation, particularly through research and development (R&D) and human capital. Studies by [Haider \*et al.\*, \(2021\)](#), [Hong \*et al.\*, \(2019\)](#), and [Habib \*et al.\*, \(2019\)](#) confirm the robust positive impact of domestic and foreign R&D investments on TFP, with spillovers from trade partners further amplifying gains. This is especially evident in the works of Shahabadi and his collaborators, who, across multiple studies, demonstrate the critical role of both domestic R&D and international knowledge spillovers in Iran's agricultural and industrial sectors. In parallel, human capital emerges as a key determinant, as shown by [Adnan \*et al.\*, \(2020\)](#), [Al-Shamriya and Al-Rakhsab \(2019\)](#), and [Norouzi \*et al.\*, \(2021\)](#). However, some studies, such as [Adnan \*et al.\*, \(2019\)](#), reveal regional heterogeneity-human capital enhances TFP in East Asia but reduces it in West Asia, possibly due to structural dependencies on resource rents. This contrast highlights the importance of institutional and economic context in shaping the effectiveness of human capital.

Financial and fiscal policies also play a crucial role, though their effects are more nuanced. While [Malik \*et al.\*, \(2021\)](#) and [Shahabadi and Feli \(2011\)](#) find a positive impact of financial development on TFP, [Zourki \*et al.\*, \(2024\)](#) reveal an asymmetric negative effect of government size and taxation in Iran, indicating that excessive public sector expansion can hinder productivity. Similarly, [Li and Tran \(2025\)](#) show that higher local budget retention improves public investment efficiency and TFP in Vietnam, suggesting that fiscal decentralization can be beneficial under certain institutional arrangements. In contrast, external shocks such as natural disasters ([Malik \*et al.\*, 2021](#)), drought ([Deگو & Bekele, 2019](#)), and financial stress ([Ghasemifar \*et al.\*, 2022](#)) are found to have persistent negative effects on productivity, emphasizing the vulnerability of TFP to macroeconomic and environmental instabilities.

International linkages-including foreign direct investment (FDI), trade openness, and financial integration-also yield mixed but generally positive outcomes. Ita and [Pedro \(2021\)](#), [Pegkas \*et al.\*, \(2020\)](#), and [Aref-Al-Rahman and Annabeh \(2020\)](#) report favorable effects of FDI and financial integration on TFP, while [Bakhshali \*et al.\*, \(2021\)](#) note that although FDI's direct effect may not always be statistically significant, it contributes to global productivity convergence through technology diffusion. However, [Deگو and Bekele](#)

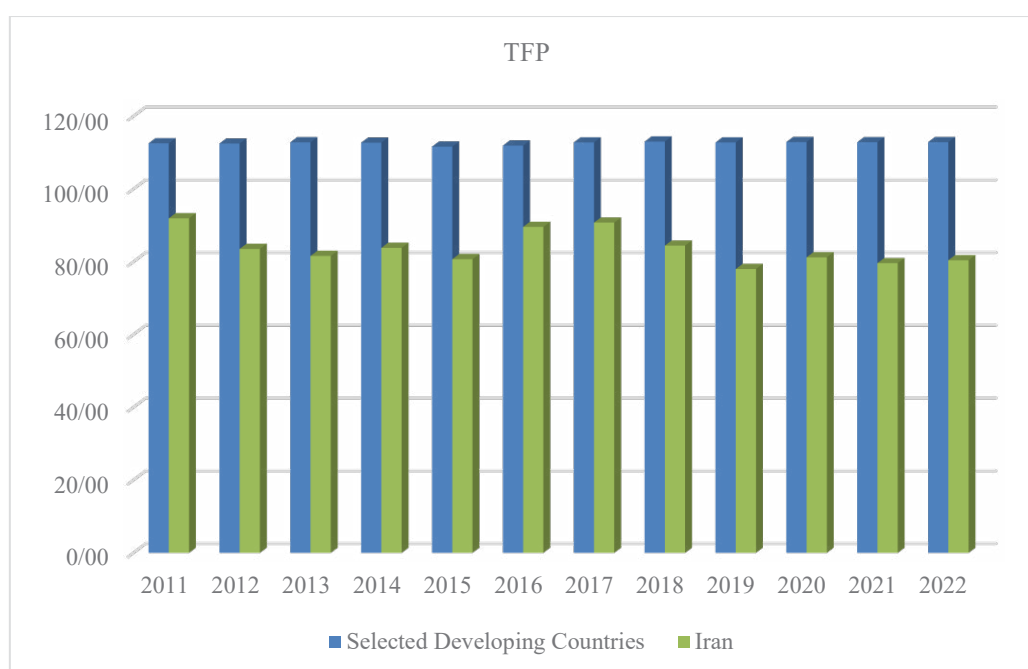
(2019) caution that in some developing economies like Ethiopia, FDI and government spending can have long-term negative impacts, possibly due to dependency or inefficiency. Energy use, particularly fossil fuels, is another critical differentiator: Jafari *et al.*, (2019) and Shojaei *et al.*, (2024) find that high oil consumption reduces TFP, especially in resource-dependent economies, whereas renewable energy and energy efficiency contribute positively. Overall, these comparative insights reveal that while technological and human capital investments consistently enhance productivity, the effectiveness of financial, trade, and energy policies depends heavily on institutional quality, economic structure, and regional context.

In general, based on studies conducted on the factors affecting TFP growth, the main emphasis has been on the role of technology (digitalization, smart manufacturing, innovation), macroeconomic policies and variables (inflation, financial development, government size), and institutional variables (good governance, social capital). They have also examined the effect of energy variables (fossil fuel consumption, renewable energy) and geographical-economic factors (urbanization, natural disasters) on total factor productivity. Several studies, mainly by Shahabadi *et al.*, have examined the impact of knowledge components on the growth of total factor productivity in Iran and other selected countries. However, the present study, in addition to using the knowledge-based approach and using components such as domestic research and development, foreign research and development spillovers, human capital, and economic freedom, also includes the property rights variable in its analysis. This is because property rights, in terms of protecting the motivation of economic actors, lead to the growth of innovation and, consequently, the growth of total factor productivity. While in previous studies, this variable has not been considered in the presented models.

### 3. Statistical facts

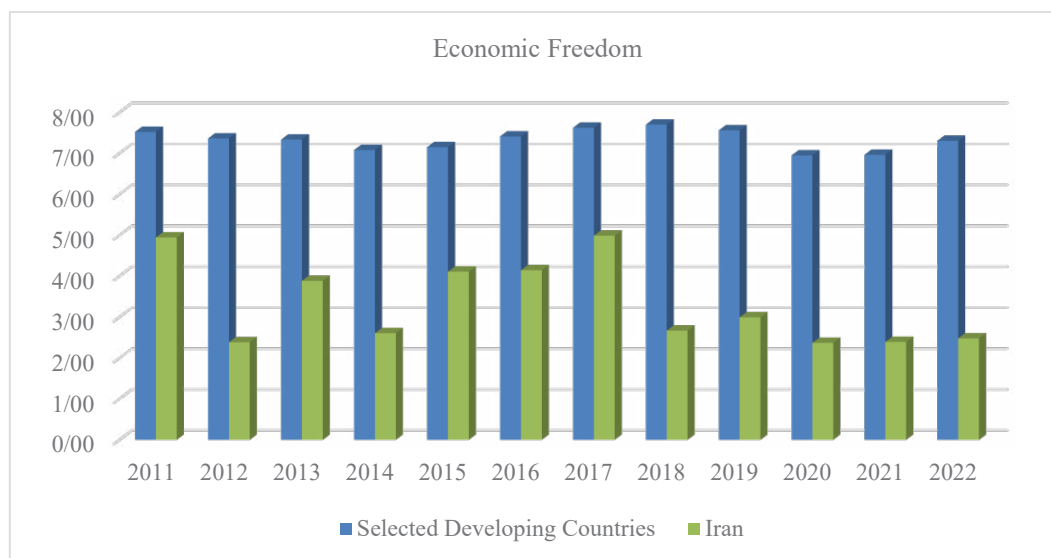
The importance of examining the growth of total factor productivity becomes more tangible and clear when the statistical gap between countries is revealed. In this case, it may be better to find the missing link in economies that suffer from low levels of productivity in their production. Although the economic conditions and structures of countries are different, it is possible to better compare countries in terms of the causes of growth or lack of growth in total factor productivity by using the variables of domestic research and development growth, foreign research and development spillovers, human capital, economic freedom, and property rights. In this part of the research, the situation of Iran, as some country rich in resources, each of which can be used as a factor of production, is

specifically compared with other selected developing countries in the present study. Figure 1 shows the comparison of the trend in total factor productivity between selected developing countries and Iran. Of course, the important point is that changes in total factor productivity occur slowly, and for this reason, even a one-unit difference between the group of countries studied in this area indicates a high gap between the economic structure of the two groups of countries studied, and in fact, even a one-unit difference can seem significant to economic thinkers. It is also clear from Figure 1 that there is a very deep gap between the total factor productivity of the Iranian economy and other selected developing and developed countries studied.



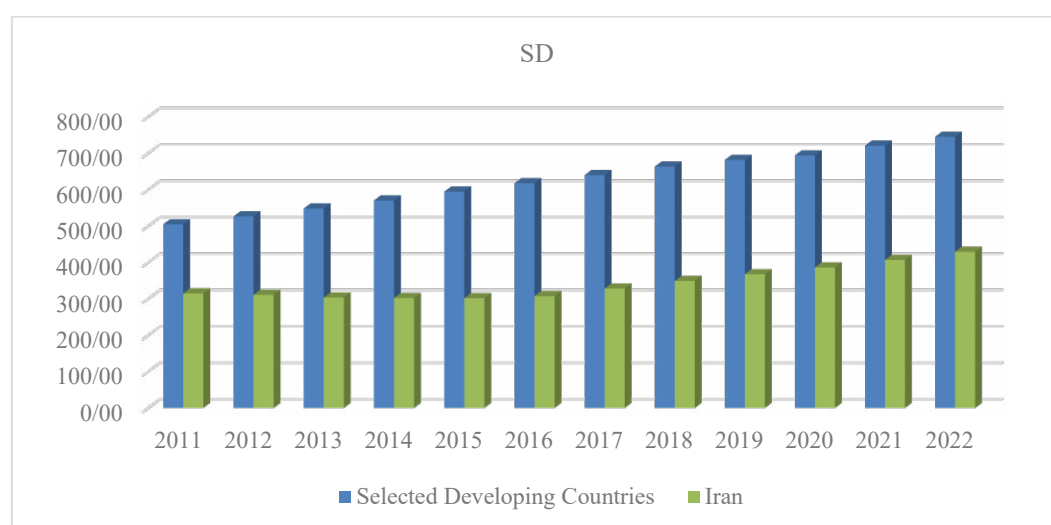
**Chart 1: Average Total Factor Productivity Trends in Selected Developing Countries and Iran (Research Findings and <https://ourworldindata.org>).**

Figure 2 compares the trend of the Economic Freedom Index. According to this chart, Iran has always been significantly lower than other selected developing countries. Iran's highest Economic Freedom Index was in 2017, but since then, the index has dropped sharply. Thus, on average, during the period under review, the selected developing countries and Iran have been assigned indices of 7 and 3, respectively.

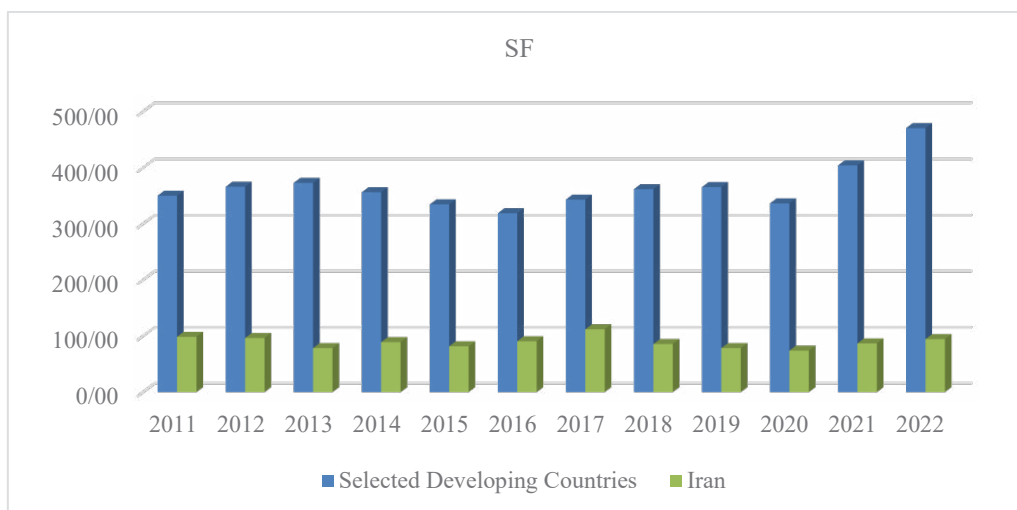


**Chart 2: Average trend of the Economic Freedom Index of selected developing countries and Iran (Research findings and <https://efotw.org>).**

Also, Figures 3 and 4 examine the gap in the average trend of domestic R&D and R&D spillovers between selected developing countries and Iran. Thus, it can be seen that there is a deep gap between the selected developing countries and Iran regarding domestic R&D spending and R&D spillovers, and this can explain part of the per capita investment gap between the selected developing countries and Iran. Therefore, according to Figures 5 and 6, we can witness a significant gap in domestic R&D spending and R&D spillovers in Iran compared to the selected developing countries. Of course, the low volume of Iran's R&D spillovers is not without the impact of international sanctions during the period under study.

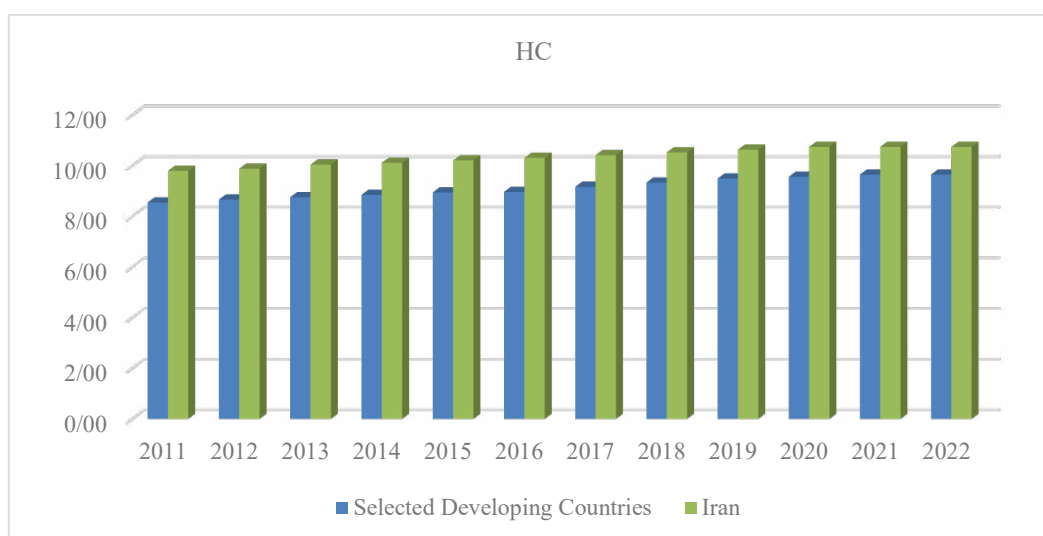


**Chart 3: Average trend of domestic R&D in selected developing countries and Iran (Research findings and <https://databank.worldbank.org>)**



**Chart 4: Average trend of R&D spillovers of selected developing countries and Iran**  
(Research findings and <https://www.trademap.org>)

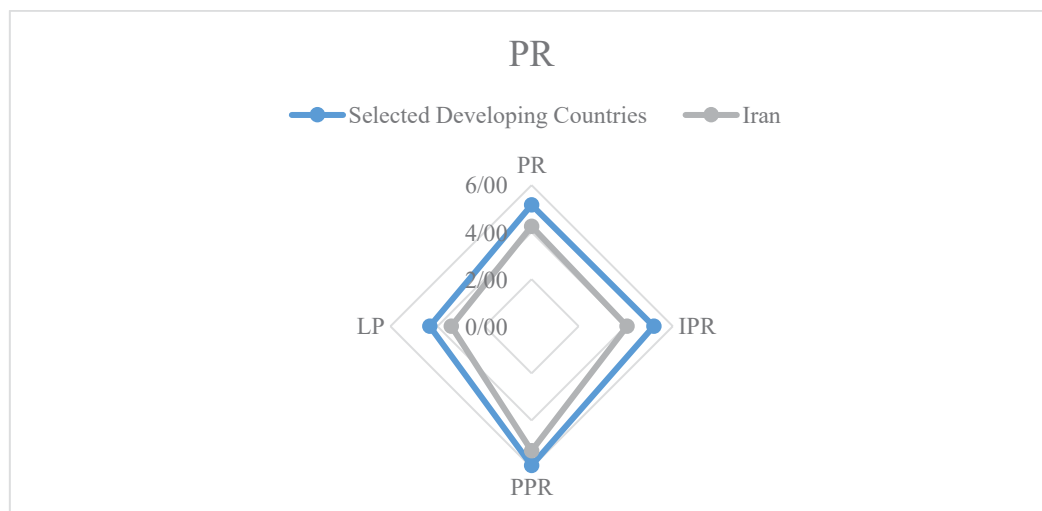
Also, Figure 5 shows the gap between selected developing countries and Iran regarding the human capital variable. According to the chart, Iran has always been above the average of other selected developing countries in terms of the human capital index.



**Chart 5: Human Capital Trends in Selected Developing Countries and Iran** (Research Findings and <https://hdr.undp.org>)

Property rights, which are considered to be factors facilitating production in the economy, have 3 components, each of which is shown in Figure 6, in the gap between the two selected developing countries and Iran. The top of the graph is the variable (PR), which has a gap that is almost the same as the gap between the variables LP (legal property rights), IPR (intellectual property rights), and PPR (physical property rights) between the selected

developing countries and Iran. However, this gap is less for the physical property rights variable than for other variables and more for legal property rights and intellectual property rights. In all components of property rights, Iran has a lower score than other selected developing countries, and this has caused the overall property rights index of Iran to decrease compared to other countries studied. Of course, regarding physical property rights, Iran's situation is better than that of other components of property rights, and it has a very small gap with other selected developing countries in this component of property rights.



**Chart 6: Average property rights index and its three components between selected developing countries and Iran during the period (2011-2017) (Source: Research findings and <https://internationalpropertyrightsindex.org>)**

#### 4. Research Method

In equation (1), based on the mechanisms presented in the theoretical foundations section, the total factor productivity variable is considered as the dependent variable and the variables of domestic R&D accumulation, R&D spillovers, human capital, economic freedom, and property rights are considered as explanatory variables, which is shown in the equation below.

$$TFP=f(SD, SF, PR, HC, EF)(1)$$

TFP: Total Factor Productivity, SD: Domestic R&D Stock, SF: R&D Spillovers, EF: Economic Freedom, HC: Human Capital, and PR: Property Rights

The above equation can also be expressed for selected developing countries as follows, where equation (2) considers the general property rights index and equation (3) considers the interactive effect of property rights and domestic R&D:

$$\ln(TFP)_{it} = \alpha_0 + \alpha_1 \ln(SD)_{it} + \alpha_2 \ln(SF)_{it} + \alpha_3 \ln(EF)_{it} + \alpha_4 \ln(PR)_{it} + \alpha_4 \ln(HC)_{it} + \mu_{it} \quad (2)$$

$$\ln(TFP)_{it} = \beta_0 + \beta_1 \ln(HC)_{it} + \beta_2 \ln(SF)_{it} + \beta_3 \ln(EF)_{it} + \beta_4 \ln(SDPR)_{it} + \vartheta_{it} \quad (3)$$

Equation (2) is fitted using panel data for the period 2011-2022 and its statistical population is a selection of developing countries.

In equation (3),  $\delta$  is the depreciation rate. The following method has been used to calculate the stock of domestic R&D (SD) (Grillich, 1988):

$$SD_t = (1 - \delta) * SD_{t-1} + R\&D_t \quad (4)$$

The initial value  $SD_0$  is calculated as follows:

$$SD_0 = \frac{R\&D_0}{(\delta + g)} \quad (5)$$

The value of  $(g)$  is also calculated from the following equation:

$$g = \frac{\ln \left( \frac{R\&D_{2004}}{R\&D_{1990}} \right)}{15} \quad (6)$$

R&D spillovers (SF) are calculated using the Coe and Helpman method as follows. In other words, R&D spillovers are usually calculated as a weighted sum of the R&D stock of other countries (Coe and Helpman, 1995):

$$SF_{it} = \sum_{j \neq i} \omega_{i,j} \cdot SD_{jt} \quad (7)$$

The following method is used to calculate weight:

$$\omega_{ij} = \frac{Import_{ij}}{\sum_{i \neq j} Import_{ij}} \quad (8)$$

Inspired by theoretical foundations, it is expected that the sign of the estimated coefficients of all explanatory variables introduced in equation (2) will be positive.

**Table 1: Statistical source of variables in the interaction effect equation of property rights and research and development**

| Variable type | Variable name                                     | Latin symbol | Statistical source                                                                                                                               |
|---------------|---------------------------------------------------|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| Dependent     | Total factor productivity                         | TFP          | <a href="https://ourworldindata.org">https://ourworldindata.org</a>                                                                              |
| Explanation   | Accumulation of domestic research and development | SD           | <a href="https://databank.worldbank.org">https://databank.worldbank.org</a>                                                                      |
| Explanation   | Spillovers R&D                                    | SF           | <a href="https://databank.worldbank.org">https://databank.worldbank.org</a><br><a href="https://www.trademap.org/">https://www.trademap.org/</a> |
| Explanation   | Economic freedom                                  | EF           | <a href="https://efotw.org">https://efotw.org</a>                                                                                                |
| Explanation   | Property rights                                   | PR           | <a href="https://internationalpropertyrightsindex.org">https://internationalpropertyrightsindex.org</a>                                          |
| Explanation   | Human capital                                     | HC           | <a href="https://hdr.undp.org/data-center/documentation-and-downloads">https://hdr.undp.org/data-center/documentation-and-downloads</a>          |

## 5. Model Estimation and Results Analysis

Based on the results of the cointegration test in Table (2), since its probability statistic is less than 5%, the H0 hypothesis that there is no cointegration is rejected, and the existence of a long-term relationship between the variables is confirmed.

Also, based on the results of the F-Limmer test, the data of the variables under study in the equation of determinants of total factor productivity are of a mixed nature. Therefore, according to the probability statistic obtained from this test, the H0 hypothesis that the data is a pool is rejected.

The results of the Hausman test also indicate that the sections do not differ structurally from each other and their difference are random. Thus, considering that the probability statistic is greater than 5%, the H0 hypothesis that there are random effects of having a model is accepted.

The cross-sectional correlation test, whose H0 assumption is that there is no correlation between the cross-sectional areas, is also confirmed, given that the probability statistic value is greater than 5%. Therefore, this H0 assumption is confirmed, so there is no correlation between the cross-sectional areas.

**Table 2: Results of the recognition tests of equations 2 and 3**

| Test                     | H0 hypothesis    | Equation (2)                      | Equation (3)                      |
|--------------------------|------------------|-----------------------------------|-----------------------------------|
| Cointegration            | No Cointegration | Prob: 0.002<br>Result: H0 Reject  | Prob: 0.000<br>Result: H0 Reject  |
| Cross-section Dependence | No Correlation   | Prob: 0.4229<br>Result: H0 Accept | Prob: 0.4256<br>Result: H0 Accept |
| F-Limmer                 | Pool             | Prob: 0.000<br>Result: H0 Reject  | Prob: 0.000<br>Result: H0 Reject  |
| Hausman                  | Random Effect    | Prob: 0.5556<br>Result: H0 Accept | Prob: 0.5346<br>Result: H0 Accept |

(Research findings).

Based on the results of Table (3), all variables are at the non-stationary level and have become stationary in the first-order difference.

**Table 3: Results of the stationarity test of variables Equations 2 and 3**

| Variable | Test       | Result                       |
|----------|------------|------------------------------|
| TFP      | Stationary | Nonstationary in Level– I(1) |
| SD       |            | Nonstationary in Level– I(1) |
| SF       |            | Nonstationary in Level– I(1) |
| EF       |            | Nonstationary in Level– I(1) |
| PR       |            | Nonstationary in Level– I(1) |
| HC       |            | Nonstationary in Level– I(1) |

(Research findings).

Table 4 shows the results of estimating equations 2 and 3, which include the coefficients of the explanatory variables along with information on the significance or non-significance of their relationship with the dependent variable. The results obtained in relation to the statistical population of selected developing countries are analyzed as follows:

The growth of domestic R&D accumulation in developing countries can have a positive impact on the growth of total factor productivity (TFP) because R&D activities lead to innovation, technological advancement, and improvement of production processes, which directly contribute to increasing efficiency and reducing costs. Domestic R&D also enhances knowledge spillovers and enables the spread of new technologies to other sectors and industries. These effects are most evident when R&D activities are carried out in line with market needs and real demand in the economy, and are accompanied by the participation of the private and public sectors. Therefore, when R&D is carried out with careful planning, in coordination with domestic capacities, and considering economic conditions, it can play an effective role in improving total factor productivity in developing countries.

The growth of property rights in selected developing countries is due to the creation of a competitive environment, the reduction of rent seeking, and the strengthening of the rule of law, which increases the incentives of economic actors to invest, innovate, and use resources efficiently. When property rights are well defined and enforced, individuals find the necessary confidence to invest in research and development, which leads to technological progress, improved production processes, and increased total factor productivity (TFP). Also, broad and equal access to property rights provides more opportunities for the broad participation of society in economic activities and leads to the flourishing of talents and the increase of the capacity of economic professionals. Therefore, property rights play an important role in promoting productivity growth in selected developing countries by creating incentives, facilitating the optimal allocation of resources, and encouraging innovation.

The positive and significant relationship between the interactive effect of property rights and domestic research and development (PRSD) and total factor productivity (TFP) indicates the complementarity of these two variables. A high score on the property rights index increases the incentive and return on investment in R&D by providing security for intellectual property and preventing the waste of resources in rent-seeking activities. As a result, the interaction of these two factors enhances productive innovations and technological improvements and leads to the growth of production efficiency (TFP).

R&D spillovers can have a positive impact on the growth of total factor productivity (TFP) in selected developing countries, because these spillovers lead to the spread of new technologies and specialized knowledge that help improve production processes, increase efficiency, and innovation. Also, the import of high-tech goods plays an important role in knowledge transfer and enables companies to use better methods and equipment. These effects are highlighted when imported technologies are targeted and tailored to the country's economic needs and capacities, and act as a complement to domestic research and development activities. Therefore, targeted and coordinated planning for the absorption and utilization of these spillovers can effectively contribute to the growth of total factor productivity in these countries.

The impact of human capital growth on total factor productivity growth in selected developing countries has been reported to be negative. When human capital, due to a lack of coordination with the real needs of the labor market and the low willingness of firms and the government to use it, in practice leads to unemployment of educated people or improper use of the skills provided, this negative impact occurs between the two variables. Also, heavy investment in education without the necessary infrastructure to attract and utilize skilled labor causes the country's limited resources to be allocated inefficiently and, instead of increasing productivity, leads to a decrease in productivity in other sectors. Finally, weaknesses in governance and macroeconomic planning prevent human capital from becoming a real force for TFP growth.

The growth of economic freedom in developing countries has had a positive impact on the growth of total factor productivity (TFP) because it helps allocate resources more efficiently by reducing unnecessary regulations, facilitating the flow of capital, labor, and technology, and creating a favorable environment for entrepreneurship and innovation. Economic freedom also reduces uncertainty by strengthening contract-related institutions and encourages long-term investment in productivity-enhancing areas. These effects are more pronounced when economic freedom is accompanied by improved quality of governance institutions and sound policy management, and is applied in proportion to the level of economic development of the country. Therefore, when economic freedom is implemented with careful planning and attention to domestic capacities, it can play an effective role in increasing total factor productivity in selected developing countries.

Table 4: Estimation results of equations 2 and 3<sup>1</sup>

| Variable   | Equation (2)       | Equation (3)      |
|------------|--------------------|-------------------|
| Ln(SD)     | 0.0362<br>(0.090)  | ---               |
| Ln(SF)     | 0.896<br>(0.000)   | 0.1337<br>(0.000) |
| Ln(HC)     | -0.2377<br>(0.012) | 0.2651<br>(0.003) |
| Ln(PR)     | 0.1296<br>(0.004)  | ---               |
| Ln(EF)     | 0.0549<br>(0.015)  | 0.6036<br>(0.000) |
| Ln(SD*PR)  | ---                | 0.0768<br>(0.000) |
| Cons       | 4.2606<br>(0.000)  | 2.0637<br>(0.000) |
| R- Squared | 0.2730             | 0.4356            |

(Research findings).

Based on the findings presented in Table 4, the results of this study regarding the variable "domestic research and development" were consistent with the studies of [Haidar et al., \(2021\)](#) and [Pegkas et al., \(2020\)](#). Also, regarding the variable "foreign research and development spillovers", the results are consistent with the studies of [Siller et al., \(2021\)](#) and [Habib et al., \(2019\)](#). Regarding the variable "human capital", the results of this study are consistent with the findings of the studies of [Adnan et al., \(2020\)](#) and [Shahabadi and Sarigol \(2017\)](#). In addition, regarding the variable "property rights", the results obtained are consistent with the results of the study of [Shahabadi and Amiri \(2014\)](#). However, no study focusing on the variable of economic freedom, as well as the interactive effect of property rights and research and development, and their effect on total factor productivity has been observed; therefore, it is not possible to compare the results of the present study with other studies.

## 6. Conclusion

Total factor productivity (TFP) is one of the main indicators determining sustainable economic growth and competitiveness of countries. This concept indicates the effectiveness of the use of productive resources, including labor, physical capital, and technology. In many developing countries, the growth of total factor productivity faces challenges that prevent increased production and economic growth. Therefore, in order to

<sup>1</sup> The numbers without parentheses are the coefficients obtained from the estimation, and the numbers in parentheses are the P-Value coefficients.

remove obstacles to the growth of factor productivity in selected developing countries examined in this study, the following recommendations are presented:

Given that in the results of estimating the interactive effect of property rights and research and development on the growth of total factor productivity, the human capital variable has a negative estimated coefficient, this result was unexpected. In developing societies, although large investments are often made in the growth of human capital, governments do not create the appropriate conditions for the use of this human capital in production. Thus, the growth of human capital in these societies has not led to the growth of total factor productivity. It is recommended that macroeconomic policymakers in selected developing countries pay special attention to reforming the relative prices of factors in order to reform the economic structure in order to reform and stimulate the behavior of economic actors and the desire to use new factors of production, especially human capital, at the forefront of macroeconomic planning, because the frequency of prices, which is based on the relative prices of factors and can be determined by the government, plays a very important role in the use of human capital by the government sector and enterprises in production and the growth of total factor productivity. In fact, the government can create alignment between physical relative abundance and price relative abundance through policy tools to effectively use the human capital factor in production. Also, in order to fill the considerable technical gap with advanced economies and to optimally utilize natural resource rents in order to convert them into renewable wealth, it is necessary to avoid completely leaving prices to the market mechanism, but it is necessary to gradually move towards price determination by the market mechanism by reforming the economic structure.

Based on the estimation results, the coefficient of the property rights variable on total factor productivity is positive and significant. This shows that the protection of property rights (intellectual, physical and legal) provides the necessary incentive for innovation and investment. Thus, by maintaining and improving intellectual, physical and legal property rights, countries witness an increasing positive impact of the property rights variable on total factor productivity. In this regard, it is recommended that policymakers of countries include the independence of the judicial system, the effective implementation of antitrust laws and the prevention of illegal government interference in the market, the creation of a stable and predictable environment for asset owners (both physical and knowledge-based), and increased transparency in the transfer of national assets and resources on their agenda and attach special importance to it.

## Acknowledgments

We are grateful to the editors of the magazine and the opinion of the respected reviewer, who added to the richness of the work.

## Observation Contribution

All authors contributed adequately to this study from its beginning to its end. They all read and approved the final document.

## Conflict of Interest

Authors declared no conflict of interest.

## References

- Acemoglu, D., Johnson, S. & Robinson, J. A., (2006). "Institutions as a fundamental cause of long-run growth". In: *Handbook of Economic Growth*, 1A: 385-472. [https://doi.org/10.1016/S1574-0684\(05\)01006-3](https://doi.org/10.1016/S1574-0684(05)01006-3)
- Adnan, Z., Chowdhury, M. & Mallik, G., (2019). Foreign direct investment and total factor productivity in South Asia. *Theoretical & Applied Economics*, 2(2): 105-210. [https://ideas.repec.org/a/agr/journal/vxxviy2019i2\(619\)p105-120.html](https://ideas.repec.org/a/agr/journal/vxxviy2019i2(619)p105-120.html)
- Adnan, Z., Chowdhury, M. & Mallik, G., (2020). "Determinants of total factor productivity in Pakistan: a time series analysis using ARDL approach". *International Review of Applied Economics*, 34(6): 807-820. <https://doi.org/10.1080/02692171.2020.1792420>
- Akcigit, U. & Ates, S. T., (2021). "Ten Facts on declining business dynamism and lessons from endogenous growth theory". *American Economic Journal: Macroeconomics*, 13(1): 257–298. <https://doi.org/10.1257/mac.20180449>
- Al-Shammaria, N. & Al Rakhish, M., (2019). "Determinants of total factor productivity across MENA region". *Proceeding: International Conference on Business, Management, technology and education*. dimensions-affecting-companys-performance-a-systematic-review-of-4-databases.pdf
- Arif-Ur-Rahman, M. & Inaba, K., (2020). "Financial integration and total factor productivity: in consideration of different capital controls and foreign direct investment". *Journal of Economic Structures*, 9(1). <https://doi.org/10.1186/s40008-020-00201-9>
- Bakhshali, S., Peykarjoo, K., Hejbarkiani, K. & Memarnejad, A., (2021). "The convergence of total factor productivity in the World: The role of technology diffusion and

institutions”. *Geography (Regional Planning)*, 11(45): 794-805.  
<https://doi.org/10.22034/jgeoq.2022.291805.3148> (in persian)

- Belitz, H. & Mölders, F., (2013). *International knowledge spillovers through high-tech imports and R&D of foreign-owned firms*. Social Science Research Network, <https://doi.org/10.2139/SSRN.2239666>

- Bjørnskov, Ch. & Foss, N. J., (2010). *Do economic freedom and entrepreneurship impact total factor productivity*. <http://dx.doi.org/10.2139/ssrn.1683965>

- Borović, Z., Gligorić, D. & Trivić, J., (2020). “Impact of economic freedom on total factor productivity in former socialist countries”. *Economic Analysis*, 53(2): 95-108.

- Chang, J., Lan, Q., Tang, W., Chen, H., Liu, J. & Duan, Y., (2023). “Research on the impact of digital economy on manufacturing total factor productivity”. *Sustainability*, 15(7): 56-83. <https://doi.org/10.3390/su15075683>

- Coe, D. T., Helpman, E. & Hoffmaister, A. W., (2009). “International R&D spillovers and institutions”. *European Economic Review*, 53(7): 723-741. <https://doi.org/10.1016/j.eurocorev.2009.02.005>

- Degu, A. A. & Bekele, D. T., (2019). “Macroeconomic determinants of total factor productivity and its trend in Ethiopia”. *International Journal of Research in Business and Social Science*, 8(6): 219-228. <https://doi.org/10.20525/ijrbs.v8i6.553>

- Eita, J. H. & Pedro, M. J., (2021). “Modelling total factor productivity in a developing economy”. *Studia Universitatis Babes-Bolyai, Oeconomica*, 66(1): <https://doi.org/10.2478/subboec-2021-0005>

- Erdem, E. & Tugcu, C., (2012). “New evidence on the relationship between economic freedom and growth: A panel cointegration analysis for the case of OECD”. *Global Economy Journal*, 12(3): <https://doi.org/10.1515/1524-5861.1796>

- Falvey, R., Foster, N. & Greenaway, D., (2006). “Intellectual property rights and economic growth”. *Review of Development Economics*, 10(4): 700-719. <https://doi.org/10.1111/j.1467-9361.2006.00343.x>

- Graham, J. R., Harvey, C. R. & Rajgopal, S., (2005). “The economic implications of corporate financial reporting”. *Journal of Accounting and Economics*, 40(1-3): 3-73. <https://doi.org/10.1016/j.jacceco.2005.01.002>

- Habib, M., Abbas, J. & Noman, R., (2019). “Is human capital, intellectual property rights, and research and development expenditures really important for total factor productivity? An empirical analysis”. *International Journal of Social Economics*, 46(6): 756-774. <https://doi.org/10.1108/IJSE-09-2018-0472>

- Haider, F., Kunst, R. & Wirl, F., (2021). "Total factor productivity, its components and drivers". *Empirica*, 48: 283-327. <https://doi.org/10.1007/s10663-020-09476-4>
- Herzer, D., (2022). "The impact of domestic and foreign R&D on TFP in developing countries". *World Development*, 151. <https://doi.org/10.1016/j.worlddev.2021.105754>
- Huang, J., Cai, X., Huang, S., Tian, S. & Lei, H., (2019). "Technological factors and total factor productivity in China: Evidence based on a panel threshold model". *China Economic Review*, <https://doi.org/10.1016/j.chieco.2018.12.001>
- Jafari, S., Esfandiari, M. & Pahlavani, M., (2020). "Investigating the role of factors affecting the total factor productivity in Iran with an emphasis on human capital and renewable and non-renewable types of energy". *The Journal of Economic Policy*, 12(23): 321-344. <https://doi.org/10.22034/epj.2020.12612.2013> (in persian)
- Jafari, S., Esfandiari, M. & Pahlavani, M., (2020). "The role of factors influencing total factor productivity in East and West Asia with emphasis on human capital and oil rents". *Journal of Economic Research and Policies*, 28(93): 267-295. <http://qjerp.ir/article-1-2555-fa.html> (in persian)
- Jaffe, A. B. & Lerner, J., (2011). *Innovation and its discontents: How our broken patent system is endangering innovation and progress, and what to do about it*. Princeton University Press. <https://www.nber.org/system/files/chapters/c0204/c0204.pdf>
- Jahangard, E., Mohammadi, T., Salem, A. A. & Esmaeily Sadrabadi, F., (2023). "The effect of intangible investment on the total factor productivity in Iran's industries". *Quarterly Journal of Quantitative Economics*, 20(3): 78-109. <https://doi.org/10.22055/jqe.2021.37224.2363> (in persian)
- Kijek, A. & Kijek, T., (2020). "Nonlinear effects of human capital and R&D on TFP: Evidence from European regions". *Sustainability*, 12(5): <https://doi.org/10.3390/su12051808>
- Komijani, A. & Shahabadi, A., (2001). "The effect of foreign (through foreign trade) & domestic R&D activities on the Iranian total factor productivity". *Iranian Journal of Trade Studies*, 5(18): 29-68. <https://sid.ir/paper/7346/en> (in persian)
- Le, D. V. & Tran, T. Q., (2025). "Central budget allocation regime and total factor productivity in Vietnam: A decomposition approach". *Economia*, 26(1): 67-88. <https://doi.org/10.1108/ECON-11-2023-0187>
- Li, P., Liu, J., Lu, X., Xie, Y. & Wang, Z., (2024). "Digitalization as a factor of production in China and the impact on total factor productivity (TFP)". *Systems*, 12(5): 164. <https://doi.org/10.3390/systems12050164>

- Liu, Y. & Zuo, Y., (2025). "Implementing intelligent manufacturing policies to increase the total factor productivity in manufacturing: Transmission mechanisms through construction of industrial chains". *International Journal of Production Economics*, <https://doi.org/10.1016/j.ijpe.2024.109468>
- Malik, M. A., Masood, T. & Sheikh, M. A., (2021). "Econometric analysis of total factor productivity in India". *The Indian Economic Journal*, 69(1): 88-104. <https://doi.org/10.1177/0019466220988066>
- Markowska-Przybyła, U., (2020). "Does social capital matter for total factor productivity? Exploratory evidence from Poland". *Sustainability*, 12(23): <https://doi.org/10.3390/su12239978>
- Murphy, K. M., Shleifer, A. & Vishny, R. W., (1993). "Why is rent-seeking so costly to growth?". *American Economic Review*, 83(2): 409-414. <https://www.jstor.org/stable/2117699>
- Norozi, F., Nonejad, M., Ebrahimi, M. & Khodaparast Shirazi, J., (2021). "Investigation of productivity growth factors in Iran using artificial neural networks algorithm". *Economic Growth and Development Research*, 11(42): 58-35. <https://doi.org/10.30473/egdr.2019.48433.5378> (in persian)
- Park, W. G. & Ginarte, J. C., (1997). "Intellectual property rights and economic growth". *Contemporary Economic Policy*, 15(3): 51-61. <https://doi.org/10.1111/j.1465-7287.1997.tb00477.x>
- Pegkas, P., Staikouras, C. & Tsamadias, C., (2020). "Does domestic and foreign R&D capital affect total factor productivity? Evidence from Eurozone countries". *International Economic Journal*, 34(2): 258-278. <https://doi.org/10.1080/10168737.2020.1734645>
- Qasemifar, S., Shahabadi, A., Shirinbakhsh, S., Mousavi, M. & Ahmadyan, A., (2023). "Evaluating the effects of systemic stress on total factor productivity with bayesian approach: A case study of Iranian economy". *Economic Growth and Development Research*, 13(49): 32-13. <https://doi.org/10.30473/egdr.2021.58993.6216> (in persian)
- Shahab, M. R., (2022). "The Study of the relationship between exchange rates and the total factor productivity (TFP) growth: An empirical analysis based on panel data in selected countries". *Journal of Development Economics and Planning*, 1(9): 23-47. (in persian)
- Shahabadi, A. & Amiri, M., (2014). "The effect of domestic R&D stock and R&D stock spillovers on total factor productivity growth of agriculture sector in Iran". *Journal of Applied Economics Studies in Iran*, 3(9): 93-114. <https://dor.isc.ac/dor/20.1001.1.23222530.1393.3.9.6.8> (in persian)

- Shahabadi, A., (2003). "An investigation of the determining factors in Iran's total factor productivity". *The Journal of Economic Studies and Policies*, 38: 27-58. [https://economic.mofidu.ac.ir/article\\_47043.html?lang=en](https://economic.mofidu.ac.ir/article_47043.html?lang=en) (in persian)
- Shahabadi, A. & Mohammadi, A., (2019). "The effect of efficiency enhancers factors on total factor productivity with the emphasis on technological readiness in selected countries". *Journal of International Business Administration*, 2(3): 45-62. <https://doi.org/10.22034/jiba.2019.9173> (in persian)
- Shahabadi, A. & Sarigol, S., (2017). "Direct and indirect effects of oil on total factor productivity in Iran's economy (Using simultaneous equations system)". *Economic Growth and Development Research*, 7(28): 141-164. <https://dor.isc.ac/dor/20.1001.1.22285954.1396.7.28.9.3> (in persian)
- Shahabadi, A. & Feali, P., (2011). "The effect of financial development on total factor productivity in Iran". *Journal of New Economy & Commerce*, 6(23-24): 111-133. <https://sid.ir/paper/118612/en> (in persian)
- Shahabadi, A. & Pourmotaghi Almani, S., (2011). "The impact of brain drain on total factor productivity". *Social Welfare*, 11(42): 411-444. <https://sid.ir/paper/56777/en> (in persian)
- Shahabadi, A. & Rahmani, O., (2011). "The investigation of the effect of research and development on the Iran's industrial sector productivity". *Roshd-e-Fanavari*, 1(25): 1-10. <https://talentdevelopment.istd.ir/en/Article/20120/FullText> (in persian)
- Shojaei, R., Khalili, F., Emami Meibodi, A. & Nazari, A., (2024). "The effect of energy consumption (oil) on the total factors of productivity in Iran and developing countries". *Iranian Energy Economics*. <https://doi.org/10.22054/jiee.2024.78466.2072> (in persian)
- Siller, M., Schatzer, T., Walde, J. & Tappeiner, G., (2021). "What drives total factor productivity growth? An examination of spillover effects". *Regional Studies*, 55(6): 1129-1139. <https://doi.org/10.1080/00343404.2020.1869199>
- Spithoven, A. & Merlevede, B., (2023). "The productivity impact of R&D and FDI spillovers: Characterising regional path development". *The Journal of Technology Transfer*, 48(2): 560-590. <https://doi.org/10.1007/s10961-022-09918-0>
- Wang, L., (2023). "Digital transformation and total factor productivity". *Finance Research Letters*, 58: 104-338. <https://doi.org/10.1016/j.frl.2023.104338>
- Zaroki, S., Eisazadeh roshan, Y. & Samadi Kochaksaraee, H., (2024). "Total Factor Productivity and Analysis of the Effect of Government Fiscal Policy Instruments". *Iranian*

*Economic Development Analyses*, 10(1): 177-206.

<https://doi.org/10.22051/ieda.2024.44992.1371> (in persian)

- Zhu, Y. & Sun, M., (2023). "The enabling effect of intellectual property strategy on total factor productivity of enterprises: Evidence from China's intellectual property model cities". *Sustainability*, 15(1): 549. <https://doi.org/10.3390/su15010549>

- <https://ourworldindata.org>
- <https://databank.worldbank.org>
- <https://www.trademap.org/>
- <https://efotw.org>
- <https://internationalpropertyrightsindex.org>
- <https://hdr.undp.org/data-center/documentation-and-downloads>





**فصلنامه علمی مطالعات اقتصادی کاربردی ایران**  
 چاپی: ۲۵۲۰-۲۳۲۲؛ چاپی الکترونیکی: ۴۷۲۸-۲۳۲۲ - وبسایت نشریه: <https://aes.basu.ac.ir>  
 نشریه گروه اقتصاد، دانشکده علوم اقتصادی و علوم اجتماعی، دانشگاه بوعلی سینا، همدان، ایران.  
 حق انتشار این مستند، متعلق به نویسنده(گان) آن است. ۱۴۰۴ - ناشر این مقاله، دانشگاه بوعلی سینا است.  
 این مقاله تحت گواهی زیر منتشر شده و هر نوع استفاده غیرتجاری از آن مشروط بر استناد صحیح به مقاله و با رعایت شرایط مندرج در آدرس زیر مجاز است.  
 Creative Commons Attribution-NonCommercial 4.0 International license (<https://creativecommons.org/licenses/by-nc/4.0/>)



## تأثیر تعاملی حقوق مالکیت و تحقیق و توسعه بر بهره‌وری کل عوامل تولید

ابوالفضل شاه‌آبادی<sup>۱</sup>، مائده ترکمانی<sup>۲</sup> ID

نوع مقاله: پژوهشی

شناسه دیجیتال: <https://doi.org/10.22084/aes.2025.31417.3819>

تاریخ دریافت: ۱۴۰۴/۰۵/۲۵، تاریخ بازنگری: ۱۴۰۴/۰۶/۲۲، تاریخ پذیرش: ۱۴۰۴/۰۶/۲۵

صص: ۱۵۳-۱۸۱

### چکیده

بهره‌وری کل عوامل تولید به عنوان یکی از شاخص‌های کلیدی رشد اقتصادی بلندمدت و نشان‌دهنده کارایی استفاده از نهاده‌های تولید در فرآیند تولید است. بهبود بهره‌وری کل عوامل تولید نه تنها منجر به رشد اقتصادی پایدار می‌گردد، بلکه نقش بسیار تعیین‌کننده‌ای در افزایش قدرت رقابت‌پذیری بین‌المللی ایفا می‌کند؛ بدین ترتیب، ارتقاء بهره‌وری کل عوامل تولید به عنوان موتور محرکه رشد اقتصادی پایدار، همواره یکی از دغدغه‌های اصلی سیاست‌گذاران و پژوهشگران اقتصادی بوده است. این پژوهش با تمرکز بر نقش انباشت تحقیق و توسعه داخلی، سرریز فناوری از طریق تحقیق و توسعه شرکای تجاری، سرمایه انسانی، حقوق مالکیت و آزادی اقتصادی، در پی تبیین سازوکارهای مؤثر بر بهره‌وری کل عوامل تولید کشورهای منتخب درحال توسعه در بازه زمانی ۲۰۲۲-۲۰۱۱ م. است. براساس یافته‌های تحقیق، متغیرهای انباشت تحقیق و توسعه داخلی تأثیر مثبت و بی‌معنا و سرریز تحقیق و توسعه خارجی، حقوق مالکیت و آزادی اقتصادی اثر مثبت و معناداری بر بهره‌وری کل عوامل تولید داشته‌اند؛ هم‌چنین اثر تعاملی حقوق مالکیت و تحقیق و توسعه داخلی بر بهره‌وری کل عوامل تولید نیز مثبت و معنادار بوده است.

**کلیدواژگان:** آزادی اقتصادی، تحقیق و توسعه، حقوق مالکیت، سرریز فناوری، سرمایه انسانی.

**طبقه‌بندی JEL:** O32, J24, D24.

۱. استاد گروه اقتصاد دانشکده علوم اجتماعی و اقتصادی، دانشگاه الزهراء، تهران، ایران (نویسنده مسئول).

Email: [a.shahabadi@alzahra.ac.ir](mailto:a.shahabadi@alzahra.ac.ir)

۲. کارشناسی ارشد علوم اقتصادی، گروه اقتصاد دانشکده علوم اجتماعی و اقتصادی، دانشگاه الزهراء، تهران، ایران.

Email: [torkamanimaede@gmail.com](mailto:torkamanimaede@gmail.com)



# Contents

|                                                                                                                                        |         |
|----------------------------------------------------------------------------------------------------------------------------------------|---------|
| The Impact of Shadow Banking on the Transmission of Monetary Policy in Iran:<br>A DSGE Model Approach                                  | 9-41    |
| <b>Mehran Zarei, Marziyeh Esfandiari, Seyed Hossein Mirjalili</b>                                                                      |         |
| Financialization and Welfare in Iran: The Institutional Quality Paradox                                                                | 43-65   |
| <b>Reza Maaboudi, Ramin Khochiany, Younes Nademi</b>                                                                                   |         |
| Investigating the Impact of Uncertainty in Influential Factors on the Ecological<br>Footprint in Selected Asian and European Countries | 67-91   |
| <b>Masoud Cheshmaghil, Javad Shahraki, Reza Ashraf Ganjoei</b>                                                                         |         |
| Evaluating the Economic Potential of Iran's Football Industry: A Performance<br>Gap Analysis                                           | 93-119  |
| <b>Hamid Kordbacheh, Niloofar Maleki</b>                                                                                               |         |
| Stock Return Forecasting Using Dynamic Nonlinear Methods: Parametric and<br>Nonparametric Modeling                                     | 121-151 |
| <b>Seyed Ehsan Hosseinidoust, Mohammad Hassan Fotros</b>                                                                               |         |
| The Interactive Effect of Property Rights and Research & Development on Total<br>Factor Productivity                                   | 153-181 |
| <b>Abolfazl Shahabadi, Maede Torkamani</b>                                                                                             |         |

## Applied Economics Studies, Iran (AESI)

Vol. 14, No. 55, 2025

P. ISSN: 2322-2530

E. ISSN: 2322-472X

Owner & Publisher: **Bu-Ali Sina University**

In collaboration with: **Scientific Association of Regional**

**Development Economy**

Responsible Manager: **Saeid Isasazadeh**

Editor-in-Chief: **Mohammad Hassan Fotros**

Executive Director: **Ismaeil Torkamani**

Internal manager and expert: **Khalil-ollah Beik-Mohammadi**

English editor: **Azar Sarmadijuo**

Logo designer: **Hamidreza Chaterbahr**



### Editorial Board (in alphabetical order)

**Mohsen Bahmanioskoei** (Professor, Department of Economics, University of Wisconsin, USA)

**Mohammad Hashem Pesaran** (Professor, Department of Economics, Cambridge University, England)

**Mohammad Reza Farzanegan** (Professor, Department of Economics, Philips Marburg University, Germany)

**Amir Kia** (Professor, Department of Economics, University of Utah, USA)

**Esfandiar Masoumi** (Professor, Department of Economics, Emory College, USA)

**Abdul Karim Zulkafli** (Professor, Department of Economics, Faculty of Economic and Social Sciences, National University of Malaysia)

**Seyed Aziz Arman** (Professor, Department of Economics, Faculty of Economic and Social Sciences, Shahid Chamran University of Ahvaz, Ahvaz, Iran)

**Mossaieb Pahlavani** (Associate Professor, Faculty of Economics, University of Sistan and Baluchistan Zahedan, Sistan and Baluchistan, Iran)

**Saeid Rasekhi** (Professor, Department of Economics, Faculty of Economic and Social Sciences, Mazandaran University, Mazandaran, Iran)

**Mohammad Alizadeh** (Associate Professor, Department of Economics, Faculty of Economic and Social Sciences, Lorestan University, Lorestan, Iran)

**Saeid Isazadeh** (Associate Professor, Department of Economics, Faculty of Economic and Social Sciences, Bu-Ali Sina University, Hamadan, Iran)

**Ali Hossein Samadi** (Associate Professor, Department of Economics, Faculty of Economic and Social Sciences, Shiraz University, Shiraz, Iran)

**Mohammad Hassan Fotros** (Professor, Department of Economics, Faculty of Economic and Social Sciences, Bu-Ali Sina University, Hamadan, Iran)

**Mohammad Ghorbani** (Professor, Department of Agricultural Economics, Faculty of Agriculture, Ferdowsi University, Mashhad, Iran)

**Mohammad Reza Lotfalipour** (Professor, Department of Economics, Faculty of Economic and Social Sciences, Ferdowsi University, Mashhad, Iran)

**Mohammad Ali Motfekrazad** (Professor, Economic Development Department, Faculty of Economic and Social Sciences, Tabriz University, Tabriz, Iran)

**Nader Mehregan** (Professor, Department of Economics, Faculty of Economic and Social Sciences, Bu-Ali Sina University, Hamadan, Iran)

**Mahmood Houshmand** (Professor, Department of Economics, Faculty of Economic and Social Sciences, Ferdowsi University, Mashhad, Iran)

Journal Homepage: <https://aes.basu.ac.ir/>

Email: [aesi@basu.ac.ir](mailto:aesi@basu.ac.ir)

Address: Pajohesh Sq., Shahid Mostafa Ahmadi Roshan Boulvar, Bu-Ali Sina University, Central Building, Office of Scientific Journals, Hamedan, Iran. Tel: +98-81 - 31401455

© Copyright © 2025 The Authors. Published by Bu-Ali Sina University.

This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International license (<https://creativecommons.org/licenses/by-nc/4.0/>). Non-commercial uses of the work are permitted, provided the original work is properly cited.

© The Author(s)





In the Name of GOD





Bu-Ali Sina  
University

Quarterly Journal of  
**Applied Economics Studies, Iran**



Scientific Association of Regional  
Development Economics

ISSN (P.): 2322-2530

(E.): 2322-472X

55

|| Quarterly Journal of **Applied Economics Studies, Iran** || **(AESI)**

|| Vol. 14 || No. 55 || 2025 ||

- ▶ **The Impact of Shadow Banking on the Transmission of Monetary Policy in Iran...**  
Mehran Zarei, Marziyeh Esfandiari, Seyed Hossein Mirjalili 9-41
- ▶ **Financialization and Welfare in Iran: The Institutional Quality Paradox**  
Reza Maaboudi, Ramin Khochiany, Younes Nademi 43-65
- ▶ **Investigating the Impact of Uncertainty in Influential Factors on the Ecological...**  
Masoud Cheshmaghil, Javad Shahraki, Reza Ashraf Ganjoei 67-91
- ▶ **Evaluating the Economic Potential of Iran's Football Industry: A Performance...**  
Hamid Kordbacheh, Niloofar Maleki 93-119
- ▶ **Stock Return Forecasting Using Dynamic Nonlinear Methods: Parametric and...**  
Seyed Ehsan Hosseinidoust, Mohammad Hassan Fotros 121-151
- ▶ **The Interactive Effect of Property Rights and Research & Development on Total...**  
Abolfazl Shahabadi, Maede Torkamani 153-181