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India's trade corridors: A shopping time model analysis for IMEEC and INSTC

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ABSTRACT

This study evaluates India's trade potential and financial efficiency within two key corridors: the India-Middle East-Europe Economic Corridor (IMEEC) and the International North-South Transport Corridor (INSTC). This study concentrates on maximizing transaction time savings through the holding of additional real money balances, taking into account the influence of distance. An adjusted shopping time model, incorporating distances and service areas, is used. Dynamic programming calculates optimal transaction times for India's trade with members of both IMEEC and INSTC. The opportunity costs of holding money (OC) are introduced as a welfare criterion to compare the trade benefits. The study finds that distance significantly influences the optimal quantity of money for trade. India benefits more from trade with IMEEC members like the UAE, Italy, and France, and INSTC members such as Russia and Kazakhstan. IMEEC offers greater trade payoffs for India compared to INSTC, making it a more strategic option for enhancing India's global trade position. The research provides valuable insights for policymakers in optimizing trade routes and financial strategies, leveraging India's involvement in both IMEEC and INSTC for economic gain.

Contribution/ Originality: The paper proposes a new welfare criterion based on the optimal quantity of money for India's international trade with IMMEC and INSTC members. It applies a new shopping time monetary model and dynamic programming approach.

1. INTRODUCTION

Over the past twenty years, two international corridors have garnered considerable global attention: The International North-South Transport Corridor (INSTC) and the India-Middle East-Europe Economic Corridor (IMEEC). These corridors are not only crucial economic trade routes but also serve as strategic geopolitical tools for the participating *countries. The INSTC, established in 2000 by India, Iran, and Russia, spans an extensive transportation network covering approximately 7,200 kilometers and includes maritime, rail, and road routes. This corridor primarily facilitates the* movement of goods between India, Iran, Azerbaijan, and Russia, connecting major cities such as Mumbai, Tehran, Baku, Bandar Abbas, Moscow, Bandar Anzali, and Astrakhan (see Figure 1). The INSTC aims to significantly reduce freight costs and transport times, offering a viable alternative to the Suez Canal route for Europe-Asia trade (Fard, 2019). Additionally, the corridor serves as a geopolitical outlet for Russia, allowing it to mitigate the impact of Western sanctions by developing alternative trade routes with its regional allies (Zvyagelskaya & Denisov, 2020).

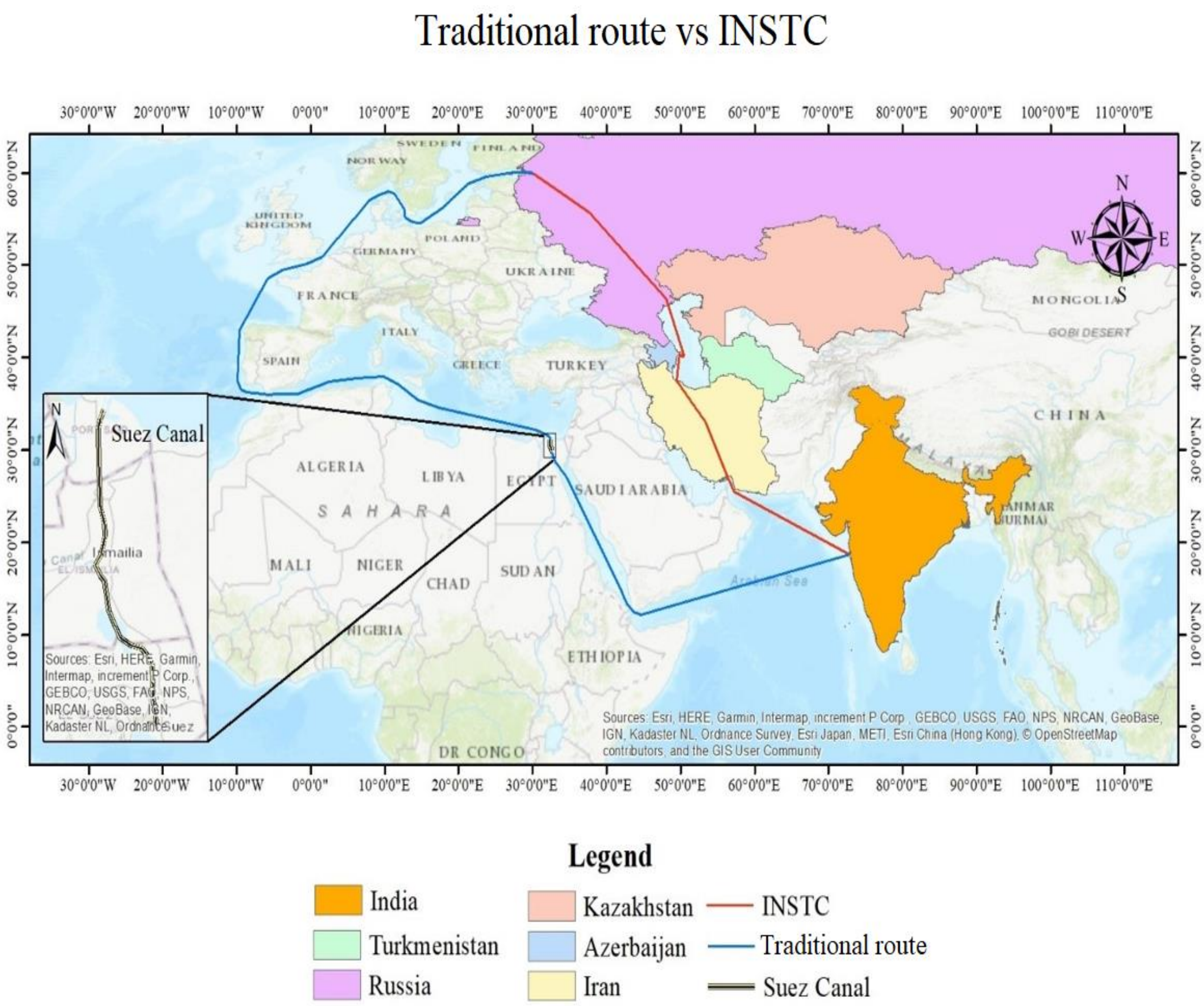

Figure 1. The international North-South transport corridor (INSTC).

The IMEEC, in contrast, is a more recent initiative. The G-20 meeting in September 2023 in India proposed the IMEEC, with the aim of enhancing connectivity and fostering economic integration between Asia, the Persian Gulf, and Europe (see Figure 2). The proposed route extends from India to Europe, traversing the United Arab Emirates, Saudi Arabia, Jordan, Israel, and Greece. Analysts suggest that the IMEEC's political motivations may outweigh its economic incentives. The United States, a key supporter of this initiative, intends to use the corridor to diminish China's growing influence in the Middle East and Europe, regions traditionally within Washington's sphere of influence (Almezaini & Rickli, 2023). By providing an alternative to China's Belt and Road Initiative (BRI), the IMEEC could shift the geopolitical balance in the region. Furthermore, the economic and political importance of the corridor has been underscored by the increasing tensions in the region, such as the Abraham Accord and the broader realignment of alliances in the Middle East (Johny, 2023).

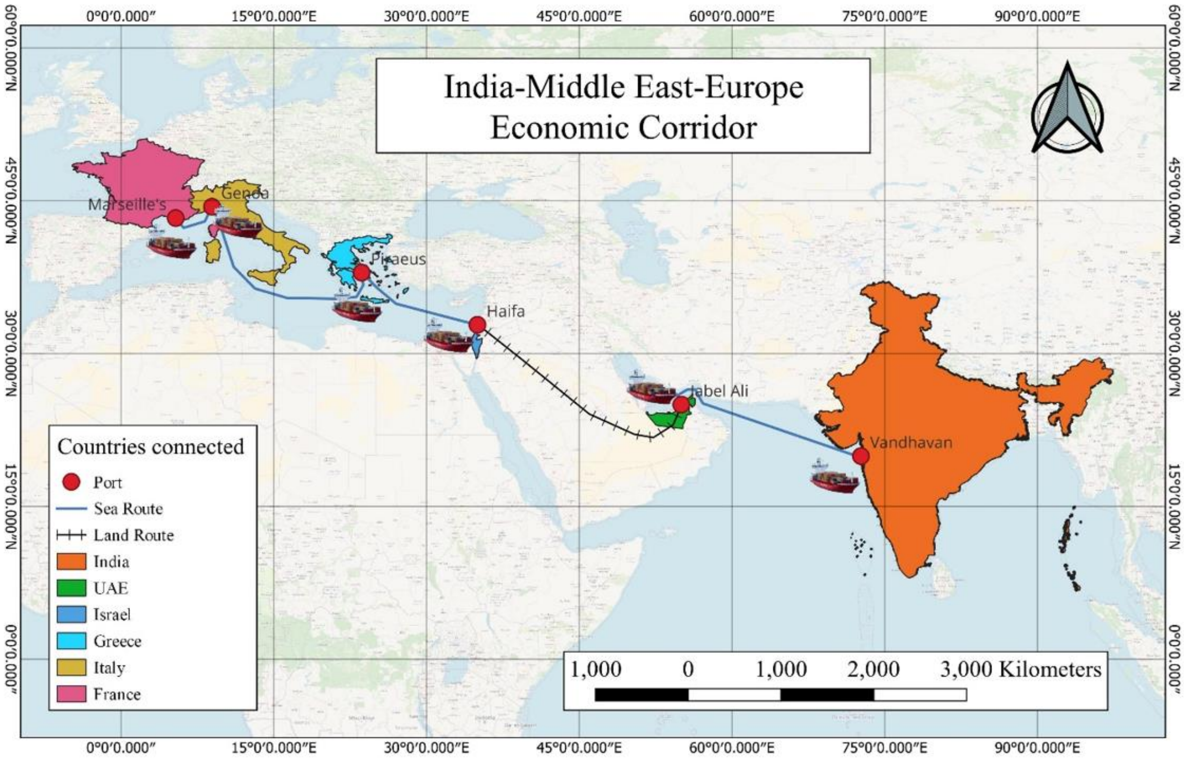

Figure 2. The India-Middle East Europe economic corridor (IMEEC).

India plays a crucial role in both the INSTC and the IMEEC. While the INSTC is nearing completion, with the Chabahar-Zahedan and Anzali-Astara railways in Iran being the main remaining links (Mitra, 2022) the IMEEC is still in the proposal stage but is expected to advance quickly due to strong political and economic support from stakeholders. This article posits that India stands to benefit commercially more from the IMEEC than from the INSTC, given the geopolitical support, geographical proximity, and economic potential of the former. Scholars have noted that regional cooperation initiatives driven by geopolitical factors often provide greater strategic advantages than purely economic corridors (Dubey, 2021).

The study focuses on the economic aspects of these corridors, guided by the hypothesis that the IMEEC will offer greater benefits to India than the INSTC. This hypothesis will be examined using the shopping time model, with two primary research questions: What are the opportunity costs of holding money (OC) for India during trade with each of the IMEEC and INSTC member countries? Which corridor results in lower OC for India?

To address these questions, the shopping time model will be used to derive a new criterion for comparing the benefits of the IMEEC and INSTC member countries: the opportunity cost of holding money, accounting for distance. According to the shopping time theory of money demand, trade time represents a transaction cost that affects the demand for money (Bein & Howells, 2003). Longer trade distances and durations lead to higher opportunity costs of holding money, potentially resulting in increased interest rates and inflation. As OC is calculated within the process of money demand (Khan, Singh, & Kumar, 2024) trade distance must be factored into this calculation. A corridor that reduces trade distance will lower the OC, thereby decreasing interest rates and inflation. In this context, the IMEEC's shorter routes compared to the INSTC could theoretically lead to lower OCs for India.

Dynamic programming will be utilized to calculate OC by incorporating distance, developing a Bellman equation as a value function for trade between India and the member countries of the two corridors. This approach, which has been extensively used in transportation and logistics studies to optimize decision-making and resource allocation (Powell, Meisel, & Bell, 2012) addresses the methodological gaps highlighted by the Lucas critique (Lucas, 1976). The critique argued that econometric models are often inadequate for informing economic policy decisions, as they lack flexibility to adapt to changing structures. Therefore, dynamic programming offers a suitable alternative for analyzing the economic impact of the INSTC and IMEEC.

This study contributes to the literature by applying the shopping time model in a novel way to compare the economic benefits of the INSTC and IMEEC corridors. Unlike traditional cost-benefit analyses or gravity models, this research introduces a dynamic approach that considers opportunity costs associated with trade distance and time. By employing dynamic programming to assess trade efficiency between the corridors, this study provides a new framework for understanding how international trade corridors impact national economic outcomes, specifically through the lens of opportunity costs and money demand. The findings will be valuable for policymakers, particularly in India, as they strategize resource allocation and seek to maximize the benefits of their participation in multiple international trade corridors.

1.1. India's Grand Strategy in Corridor Geopolitics

The INSTC and IMEEC should be analyzed in the context of geopolitical competition. These corridors are viewed as responses to China's global transportation plans. China has sought to create a new trans-regional connectivity architecture in Eurasia, redirecting trade flows towards Beijing through its Belt and Road Initiative (BRI). This initiative aims to establish China's twin trade transport corridors to Europe, including a network of railways and land routes leading west and south of Central Asia. The backbone of the Silk Road Economic Belt, part of the BRI, consists of Chinese-built port facilities extending westward across the Indian Ocean, known as the "Maritime Silk Road of the 21st Century" (Khobragade & Nim, 2022).

In response to China's infrastructure developments, such as the construction of Pakistan's Gwadar port and the China-Pakistan Karakoram Highway, India has sought to counterbalance Beijing's influence. The establishment of the Silk Road Economic Belt and the blocking of India's land access to Central Asia by Pakistan and China increased the likelihood of India's strategic isolation in the region. Furthermore, one could perceive China's Maritime Silk Road of the 21st Century as a naval blockade of India (Tanchum, 2013).

India launched the INSTC as its initial countermeasure, aiming to establish a multimodal corridors that connect Central Asia, Russia, and Europe through Iran. The INSTC serves as a vital transit route in Central Asia, with countries along the corridor forming alliances to develop and upgrade ports, roads, terminals, and rail routes. It connects Northern Europe and Russia with the Indian Ocean, Persian Gulf, and South Asia through Iran and the Caspian Sea. The INSTC operates as a multimodal transit system, involving two sea shipments: one via the Caspian Sea and another through Iran's southern ports. It combines land and sea transport, reaching its destination by ship. The strategy includes developing a modern deep-sea port in Iran's Chabahar port, located 170 kilometers from Gwadar, and establishing land routes through Iran and Afghanistan to Central Asia. While Chabahar port serves as a crucial connecting point, the INSTC has faced geopolitical and economic challenges, including sanctions imposed on Iran and Russia by the EU and the US.

Since September 2023, the United States and India have initiated the IMEEC, which may offer a more attractive option for India due to the more stable economies of the Persian Gulf kingdoms, Jordan, and Israel compared to Iran. These countries face fewer political pressures from the West and offer potential synergistic benefits when combined with the IMEEC, creating a multi-purpose trans-regional economic corridor. India's competition with China in Iran poses challenges, but it may advantage over the IMEEC countries due to political and geographical factors. Trade between India and the EU via the IMEEC is more feasible compared to land routes through China. India aims to position itself as an alternative to China, acknowledging that it cannot fully replace China's global economic role. The IMEEC provides an opportunity for the EU to diversify trade relations, particularly given the good relations between IMEEC transit areas and the EU.

In the IMEEC initiative, UAE ports can serve as a hub for creating a separate India-Europe trade corridor. Starting from Mumbai, the IMEEC connects to Dubai via sea, then to Haifa in Israel through a rail route, and finally to the Greek port of Piraeus by sea before extending into mainland Europe. The completion of remaining railway links between the UAE and Israel, approximately 344 kilometers, is expected to be manageable. The IMEEC promises to significantly reduce travel time by almost 40% and cut transit costs by 30% compared to traditional routes (Monroe, 2023). Despite some geopolitical uncertainties, the IMEEC offers a more streamlined and economically advantageous option for India compared to the INSTC.

India has pursued an astute foreign policy to leverage its capacities along the IMEEC corridor, expediting free trade agreement talks with the UAE and the EU. With India's foreign trade exceeding $1 trillion in 2022 and the EU being a major trading partner, India is well-positioned to capitalize on the opportunities presented by the IMEEC. Greece's enhanced relations with Israel and the Arab world, coupled with improved ties with India, further strengthen the corridor's potential. Rail transport services from Piraeus through the Balkans to Central Europe facilitate access to major European markets (Faraji Nasiri, Mottaghi, & Jolani, 2024). It is crucial to emphasize that India does not intend to replace the INSTC with the IMEEC. Instead, India's strategic preference is to benefit from both corridors simultaneously, investing more where profitability is higher.

2. LITERATURE REVIEW

This literature review presents an evolving research landscape that integrates economic theory, dynamic modeling, and empirical studies to explore the comparative benefits of India's engagement in international trade via the International North-South Transport Corridor (INSTC) and the India-Middle East-Europe Economic Corridor (IMEEC). The study emphasizes the importance of developing a new shopping time model, rooted in concepts from dynamic programming, economic trade-offs, and geographical analysis. The study highlights (Bellman, 1957) as a key tool for optimizing decisions over time, providing a dynamic approach to evaluating trade patterns. This is coupled with the principle of opportunity cost (Henderson & Quandt, 1958) underscoring the necessity of weighing alternatives in resource allocation. Service area analysis by ReVelle and Eiselt (2005) further enriches the theoretical foundation, examining spatial distribution and accessibility, which are crucial for understanding market efficiency and economic behavior. Together, these concepts form a robust framework for the study.

Key frameworks such as time allocation models (Becker, 1965) consumer decision-making processes (Engle & Kroner, 1995) and economic theories of demand and supply (Varian, 2014) provide additional depth to the research. These frameworks allow for a comprehensive understanding of how individuals allocate time and resources, make economic decisions, and react to market changes. The integration of empirical studies, such as Azmi and Khan (2024) who utilized machine learning to predict shopping patterns, and Sharma and Mishra (2019) who focused on seasonal impacts on rural shopping behavior, supports the relevance of these theoretical frameworks. These studies underscore the significance of socio-economic factors and market dynamics in shaping consumer decisions, which is critical for analyzing trade patterns and outcomes.

The literature further expands on the concept of shopping time, recognizes its importance in understanding the interplay between the monetary aspects of an economy and trade dynamics. For instance, Gillman (2020) extended the shopping time concept to a banking time model, demonstrating how banks can enhance social welfare by optimizing trade time in a dynamic programming context. Bastanifar (2024b) applied a shopping time model to examine the effects of COVID-19 lockdown policies on trade, showing how the timing of trade influenced the optimal discount rate for major global economies. These studies highlight the applicability of dynamic models in understanding complex trade and economic scenarios, reinforcing the need for innovative approaches in evaluating trade patterns.

Historically, research on economic corridors has prioritized political objectives over economic benefits, as noted by Bastanifar, Omidi, and Khan (2024). However, recent studies have begun to emphasize the commercial and energy security aspects of these corridors. Konings (2018) explored the logistics and transport efficiencies brought about by these infrastructure projects, while Baniya, Rocha, and Ruta (2020) and Qi, Peng, and Zhang (2019) discussed their strategic importance in enhancing trade connectivity and energy security. Recent empirical work by Khan, Khan, and Koch (2023); Khan, Bastanifar, Omidi, and Khan (2024) and Shujaat Naeem Azmi, Khan, and Koch (2024) has provided evidence of the economic benefits stemming from improved infrastructure and reduced trade barriers. Despite this progress, there remains a gap in the literature regarding the simulation and comparative analysis of the INSTC and IMEEC corridors.

The review concludes by identifying this gap and positioning the study to fill it. The research aims to provide a framework for measuring and comparing the impacts of these corridors on international trade by developing a new shopping time model specific to the INSTC and IMEEC. This approach, which integrates previous theoretical and empirical research with advanced modeling techniques, seeks to offer a more nuanced understanding of trade dynamics and economic development, contributing significantly to the body of literature on economic corridors and globalization.

3. MATERIALS AND METHOD

In our analysis, we have applied macroeconomic and geographic databases, which are summarized in Table 1 (source of variables). Interest rate is one of the key variables that has a vital role to keep an economy stable. Keynes believed in his 1936 work, "The General Theory of Employment, Interest, and Money," that monetary authorities determine the interest rate in response to the public's demand for money. He believed that in the real world, people experience uncertain situations. Therefore, they hold cash instead of financial assets (such as bonds). Therefore, interest rates are a powerful instrument for saving and investment decisions (Snowdon & Vane, 2005).

In monetary economics, it is believed that interest rate, an instrument used to measure the opportunity cost of holding money (OC), is considered an optimal condition for determining the demand for money. There are three conventional models for achieving OC, which include the money in utility function, cash in advance, and shopping time model (Handa, 2009). This paper uses shopping time model to calculate OC. The reason is that the microfoundations-of-money characteristic of a shopping time model allows to choose variables that impact the time of transaction as a proxy of transaction cost in an open transaction environment (Hueng, 1999). The model also takes into account certain political and biological aspects of trade time (Bastanifar, 2024a). Therefore, shopping time is an appropriate model to consider OC when international economic corridors matter.

The shopping time model, utilizing dynamic programming, offers a more comprehensive analysis of economic corridors compared to the cost-benefit analysis methods employed by Emadzadeh, Bastanifar, and Ebrahimi (2007); Kunaka and Carruthers (2014) and Nasir, Shah, and Ahmed (2016). The cost-benefit analysis approach often neglects the broader monetary and macroeconomic impacts of these corridors. Additionally, conventional studies that apply the gravity model (GM) with econometric methods, such as those by Bergstrand (2019); Onifade, Erdoğan, Alagöz, and Bekun (2021) and Jamagidze (2022) have faced criticism for overlooking Lucas (1976) and his alternative methodology proposed in 2000.

Economic corridors, especially IMEEC and INSTC, improve transactions (Shujaat Naeem Azmi et al., 2024; Khan & Koch, 2024) by decreasing the distance. In view of economies of scale, economic distance indicates the transport cost of trades. Economic distance, rather than physical distance, can serve as a proxy for trade costs (Haralambides, 2019). According to Table 1, author applies distance from Vadhavan port (km) for IMEEC members and distance (from Mumbai to the capital of importing countries, km) for INSTC members.

The service area determines the accessibility within the exciting infrastructural network and is shown by SER (service area) in the paper. (Khan et al., 2023) used this variable to model the availability of a specific facility within a specific distance.

In the present study, the service area of the candidate countries was incorporated, and authors modelled using the network analysis tool of ArcGIS. The dimensions of DIS and SER are in kilometers. However, this paper normalizes time to one, thereby considering these variables as ratios between zero and one.

Table 1. Source of variables.

Variables	Reference
Interest rate.	https://tradingeconomics.com/country-list/interest-rate
Distance from Vadhavan port (km)	https://www.worldometers.info/geography/largest-countries-in-the-world/
Distance (From Mumbai to the capital of importing countries, km)	Khan et al. (2023)
Service area	Vector files of road network data were accessed from NASA SEDAC (National aeronautics and space administration socioeconomic data and applications center); vector files of countries boundaries were accessed from downloaded from http://tapiquen-sig.jimdo.com developed by ESRI (Environmental systems research institute)
Opportunity cost for holding money	Authors
Note: i^g indicates the abbreviation of interest rate. Service area is presented by SER. OC presents opportunity cost for holding money	

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Figure 3 indicates the distance of trade between the IMEEC and INSTC member countries and India. It also indicates the average distance of trade in each corridor. The average distance between IMEEC member countries and India is 5672. 69 kilometers. However, it is 3418.81 kilometers for INSTC member countries.

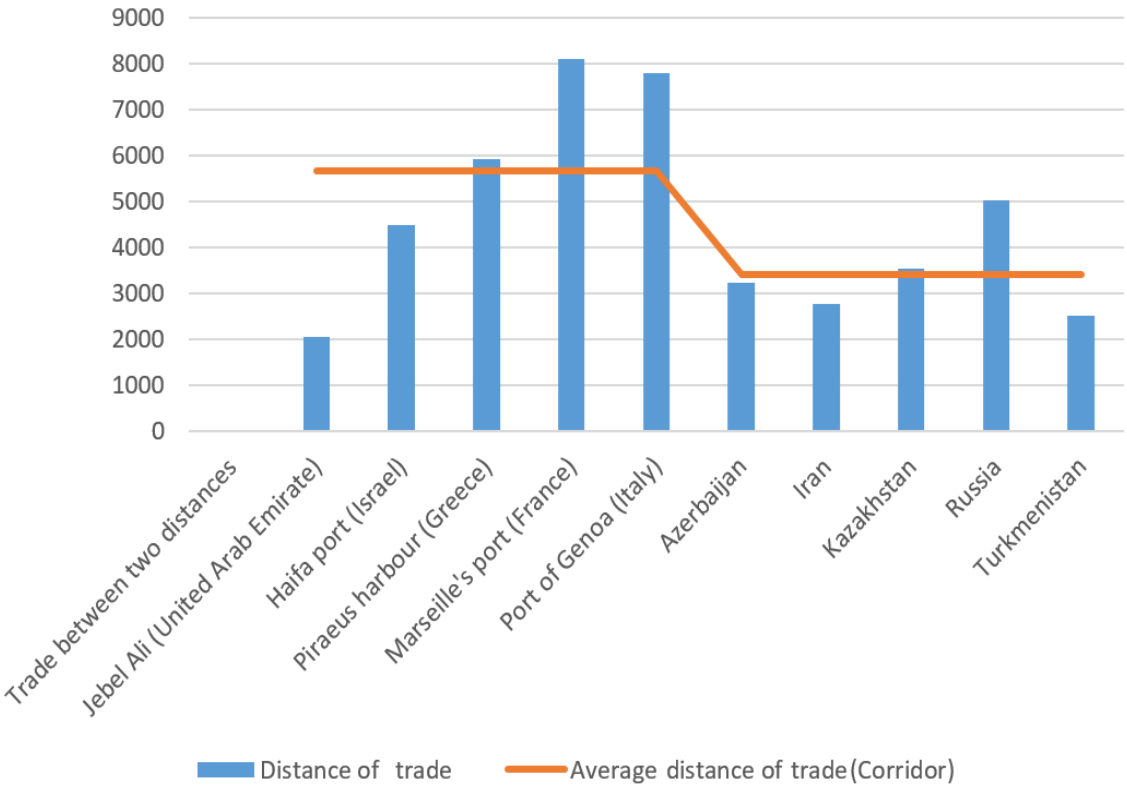

Figure 3. Distance of trade and average distance of trade.

Figure 4 indicates the service area (as percentage) of IMEEC and INSTC member countries. It also indicates the average service area in each corridor. The average service area of IMEEC member countries is 72.32. However, it is 77.32 for INSTC member countries.

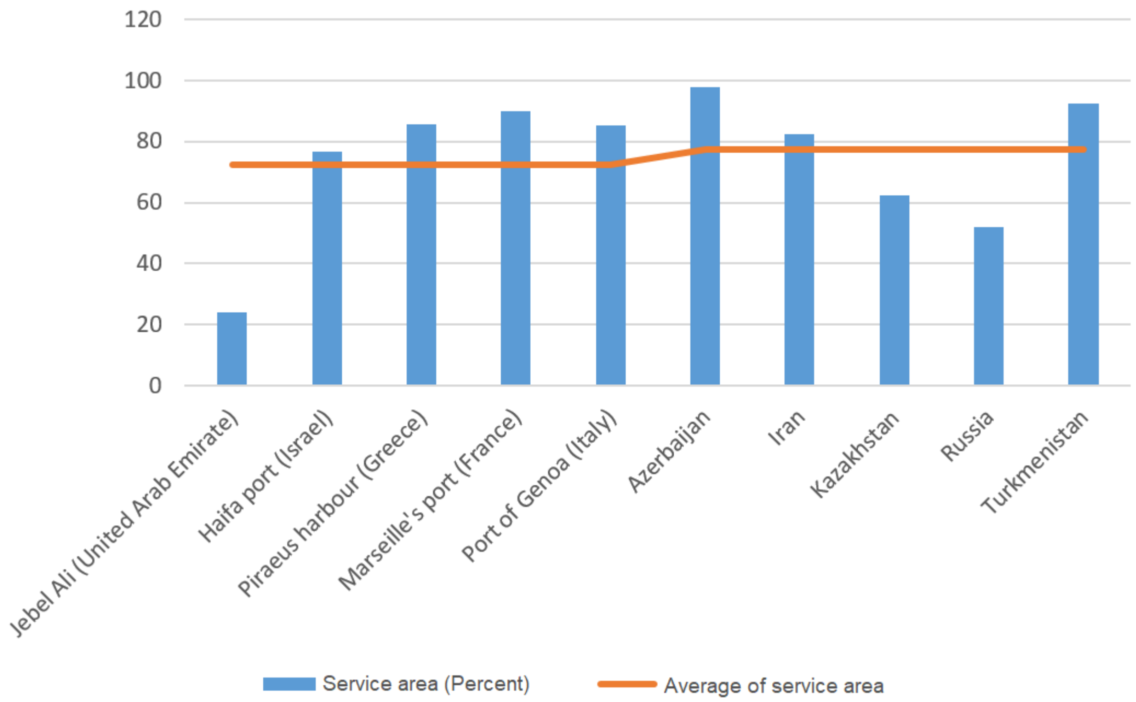

Figure 4. Distance of trade and average distance of trade.

In order to calculate OC, authors follow a new shopping time as follows:

3.1. Adjusted Shopping Time Model with Distance

A representative household utility function can be shown in Equation 1.

$$U(c.m.l) = V(C.l) \qquad (1)$$

In a shopping time model, the utility function of a household depends on consumption (*c*) and leisure(*l*). Leisure(*l*) is equal to $l=1-n^w-n^s$. Where n^w indicates working time and the time spent in the market for shopping or transactions can be seen with n^s. (Walsh, 2017). Time is normalized to one. The shopping time depends on the amount of consumption and the amount of money being held. This function can be represented as $n^s=g(c, m)$. The model assumes that the function increases when consumption increases($g_c>0$), while it decreases when real money balances increase($g_m \leq 0$).

$$l = [1 - n^w - n^s] \qquad (2)$$

We enhanced the model by including the distance factor in the model.

It is evident that the greater the distance involved in a trade, the more money we should pay. Naturally, the longer the distance, the more money should be paid. However, since distance increases the cost of transactions and leads to a prolonged time of trade, the authors provide a distance index (d_i) to indicate this point. The model is modified to include distance as a factor to accurately reflect its impact on trade, providing a more comprehensive understanding of the variables that influence trade between countries.

$$n^S = d_i g(c.m) \qquad (3)$$

Distance Index of trade (d_i) has two characteristics. The first is physical distance is indicated by DIS. Another characteristic of the index is the service area.

Since DIS and SER are between zero and one, any increase in SER can decrease the distance of trade(di). Mathematically, this relationship is specified as di=DIS^{SER}.

Since SER indicates the accessibility of infrastructural networks, it lays the groundwork for decreasing trade costs by decreasing the distance index of trade (d_i) in the model.

Therefore, according to Equation 3, when di, which is a ratio between zero and one, decreases, it leads to a reduction in the transaction time (g), and vice versa.

Now, by replacing Equation 3 in Equation 2, the new leisure time is specified as follows in a utility function:

$$u(c.m.l) = v\{c.1 - n^w - g(c.m)di\} \qquad (4)$$

Equation 5 indicates an intertemporal utility function for a representative household. β and c_t indicate the discount factor and consumption per capita at time t, respectively.

$$\sum_{j=0}^{\infty} B^j v[c_{t+j}.1 - n^w{}_{t+j} - g(c_{t+j}.m_{t+j})di] \quad 0 \le \beta \le 1 \qquad (5)$$

Subject to:

$$A_t = \tau_t.N_t + \frac{(1+i^g_{(t-1)})B^g_{(t-1)}}{P_t} + \frac{M_{(t-1)}}{P_t} \qquad (6)$$

Where

A_t is a non-human wealth, τ_t is a transfer payment, B is the total debt of a government, i^g_{t-1} is government bond yield, P_t is price index, M_{t-1} is a stock of international money.

$$Y_t + (1-\delta)K_{(t-1)} + A_t \ge C_t + K_t + \frac{M_t}{P_t} + \frac{B^g{}_t}{P_t} \qquad (7)$$

Y_t is aggregate production function. $Y_t = F(K_{t-1}.N_t.\theta_t)$.

δ, $\tau_t N_t$ and K_t are the rate of depreciation, aggregated lump-sum transfers and Physical capital respectively.

N_t is the population, θ_t is technology. $P_t = (1+\pi_t)\ P_{t-1}$ and $N_t = (1+n)\ N_{t-1}$. If we divide Equations 6 and 7 by the population, we arrive at equation8.

$$\frac{A_t}{N_t} = a_t = \tau_t + \frac{(1+i^g_{t-1}).B^G{}_{t-1}}{(1+\pi_t)(1+n)P_{t-1}.N_{t-1}} + \frac{M_{t-1}}{(1+\pi_t)(1+n)P_{t-1}.N_{t-1}} \qquad (8)$$

$$\text{Or } a_t = \tau_t + \frac{(1+i^g_{t-1}).b^g{}_{t-1}}{(1+\pi_t)(1+n)} + \frac{m_{t-1}}{(1+\pi_t)(1+n)} \qquad (9)$$

Now, the per capita budget constrain becomes:

$$y_t + \frac{(1-\delta)}{(1+n)}k_{(t-1)} + a_t \ge c_t + k_t + m_t + +b^g_t \qquad (10)$$

$W(a_t.k_{t-1})$ is the new value function or Bellman's equation

$$W(a_t.k_{t-1}) = \max[v(c_t.1 - n^w_t - g(c_t.m_t)di] + \beta E_t W(a_{t+1}.k_t) \qquad (11)$$

Where E is the indicator of expectation. Suppose we eliminate k_t and a_{t+1} from the expression for the value function. In that case, the necessary first-order conditions for labour, consumption, real money holdings, real bond holdings are obtained by chain rule:

$$\frac{\partial W(a_t.k_{t-1})}{\partial n^w_t} = \frac{\partial v}{\partial l_t}\frac{\partial l_t}{\partial n^w_t} + \beta E_t \frac{\partial W(a_{t+1}.k_t)}{\partial k_t}\frac{\partial k_t}{\partial f}\frac{\partial f}{\partial n^w_t} = 0$$

$$\Rightarrow -v_l + \beta E_t \frac{\partial W(a_{t+1}.k_t)}{\partial k_t} f_n = 0 \qquad (12)$$

f_n is marginal productivity of labor and equals to the wage of labor (in a competitive market).

$$\frac{\partial W(a_t, k_{(t-1)})}{\partial c_t} = \frac{\partial V}{\partial c_t} + \frac{\partial V}{\partial l_t}\frac{\partial l_t}{\partial g}\frac{\partial g}{\partial c_t}d_t - \beta E_t \frac{\partial W(a_{t+1}, k_{(t)})}{\partial k_t}\frac{\partial k}{\partial c_t} = 0$$

$$\Rightarrow v_c - v_l g_c d_t - \beta E_t \frac{\partial W(a_{t+1}, k_{(t)})}{\partial k_t} = 0 \qquad (13)$$

$$\frac{\partial W(a_t, k_{(t-1)})}{\partial m_t} = \frac{\partial V}{\partial l_t}\frac{\partial l_t}{\partial g}\frac{\partial g}{\partial m_t}d_t + \beta E_t[\frac{\partial W(a_{t+1}, k_{(t)})}{\partial a_{t+1}}.\frac{\partial a_{t+1}}{\partial m_t} + \frac{\partial W(a_{t+1}, k_{(t)})}{\partial k_t}.\frac{\partial k_t}{\partial m_t}] = 0$$

$$\Rightarrow -v_l g_m d_t + \beta E_t[\frac{\partial W(a_{t+1}, k_{(t)})}{\partial a_{t+1}}.\frac{1}{(1+\pi_{t+1})(1+n)} - \frac{\partial W(a_{t+1}, k_{(t)})}{\partial k_t}] \qquad (14)$$

$$\frac{\partial W(a_t, k_{(t-1)})}{\partial b^g_t} = \beta E_t[\frac{\partial W(a_{t+1}, k_{(t)})}{\partial a_{t+1}}.\frac{\partial a_{t+1}}{\partial b^g_t} + \frac{\partial W(a_{t+1}, k_{(t)})}{\partial k_t}.\frac{\partial k_t}{\partial b^g_t}] = 0$$

$$\Rightarrow \beta E_t\left[\frac{\partial W(a_{t+1}, k_{(t)})}{\partial a_{t+1}}.\frac{1+i^g_t}{(1+\pi_{t+1})(1+n)} - \frac{\partial W(a_{t+1}, k_{(t)})}{\partial k_t}\right] = 0 \qquad (15)$$

Removing $\frac{\partial W(a_{t+1},k_{(t)})}{\partial a_t+1}$ in Equations 14 by the Equations 15, replacing $\beta E_t \frac{\partial W(a_{t+1},k_{(t)})}{\partial k_t} = \frac{v_l}{f_n}$ finally, Equation 16 is extracted.

$$-g_m f_n = \frac{i_t^g}{1+i_t^g} \cdot \frac{1}{d_t} \qquad (16)$$

This optimal condition indicates that the value of the transaction time saved by holding additional real money balances equals the opportunity cost of holding money (OC).

4. CALCULATION

In a shopping time model, Equation 16 represents the OC, which serves as a social welfare criterion. This is introduced in Lucas (2000). In utility function models, this cost is equivalent to the opportunity cost of holding money. It shows how a social planner who shares the same preferences as a representative household can choose to allocate more or less money. Any increase in OC through the interest rate (i_t^g)will raise inflation and lead to instability. The more OC we have, the less welfare we get. Therefore, as a social planner, the government of India must choose trades between countries that result in less OC. Since, in addition to interest rate, the role of distance should not be overlooked, Table 2 shows the OC of trade between two distances.

Table 2. The OC of trade.

Corridors	Trade between two distances	i^g(India)	$\frac{i^g}{1+i^g}$	Distance (Km)	DIS (%)	% SER	DIS^{SER}	$\frac{1}{DIS^{SER}}$	OC
IMEEC	Jebel Ali (United Arab Emirate)	0.065	0.061	2048.838	7.2	24.2	0.530	1.887	0.115
	Haifa port (Israel)	0.065	0.061	4487.909	15.8	76.5	0.244	4.095	0.250
	Piraeus harbour (Greece)	0.065	0.061	5922.092	20.9	85.5	0.262	3.813	0.233
	Marseille's port (France)	0.065	0.061	8100.136	28.6	90.0	0.324	3.089	0.189
	Port of Genoa (Italy)	0.065	0.061	7804.471	27.5	85.4	0.332	3.010	0.184
	Total			28,363.44	100				
	Average								0.194
	Standard deviation								0.047
INSTC	Azerbaijan	0.065	0.061	3242.760	19.0	97.6	0.197	5.065	0.309
	Iran	0.065	0.061	2774.440	16.2	.82.2	0.224	4.457	0.272
	Kazakhstan	0.065	0.061	3547.180	20.8	62.2	0.376	2.657	0.162
	Russia	0.065	0.061	5025.680	29.4	52.1	0.529	1.892	0.115
	Turkmenistan	0.065	0.061	2504.000	14.6	92.5	0.169	5.915	0.361
	Total			17094.060	1.00				
	Average								0.244
	Standard deviation								0.092

For IMEEC members, the distance (in km) is calculated from Vadhavan port to other ports; for INSTC members, the distance from Mumbai to each country is considered.

The OC results from multiplying the column of $\frac{i^g}{1+i^g}$ by inverting the column of DIS^{SER}.

5. DISCUSSION AND CONCLUSION

India's diplomatic and economic alliances are pivotal in its corridor geopolitics. Engaging in multilateral forums, signing bilateral agreements, and leveraging cultural diplomacy help India build alliances that support its corridor initiatives and counterbalance the influence of rivals. Through a combination of strategic connectivity projects, regional cooperation, and robust diplomacy, India's grand strategy in corridor geopolitics aims to secure its interests, promote economic growth, and enhance its regional and global influence. This multifaceted approach ensures that India remains a key player in international trade, leveraging both economic and diplomatic tools to achieve its objectives. This research develops and applies a novel shopping time model to evaluate India's trade through the INSTC with the India-Middle East-Europe Economic Corridor's economic benefits. The research proposes the opportunity cost (OC) of retaining money as a new criterion, considering trade distance and putting it into the shopping time model, which analyses trade time as a trade cost. The study uses dynamic programming and a Bellman equation to calculate the opportunity cost (OC) of holding additional real money balances in India's commerce with member countries of both corridors, factoring in distance. India's strategic use of these corridors to maximise economic gains and negotiate geopolitical hurdles, notably in reaction to China's Belt and Road Initiative, is also examined. Including the distance factor in the model helps explain how distance affects trade costs. The precise calculations and data tables in this quantitative research help optimise India's trade routes for economic stability and prosperity. The findings based on the right side of Equation 16 indicate that the OC not only depends on the interest rate but is also influenced by the distance index (di). Since $\frac{1}{di}$ or DIS^{-SER} impact the OC, an increase in DIS leads to an increase in OC while service area decreases the OC. The significance of Equation 16 in monetary economics is crucial, as it shows that the interest rate is not the sole factor affecting OC; the distance index also plays an effective role. Therefore, in an international trade environment where transaction risk exists, Milton Friedman's idea that a zero interest rate is necessary for a zero-opportunity cost of money cannot be accepted. Expanding trade through economic corridors can reduce a society's social marginal cost, and reducing the distance between countries can reduce the openness cost (OC) of trade. This study supports the research conducted by Bastanifar et al. (2024) which applied recursive networking method to indicate that distance can impact OC of trade for members of IMEEC and INSTC. The findings also convey a message that, according to Walsh (2017) for different monetary demand models based on dynamic programming method, reaching the optimal quantity of money does not require a zero interest rate. Instead, it requires equality between different interest rates. India's trade dynamics illustrate the application of this theoretical framework to real-world scenarios. According to Table 2, India experiences various OCs during trade with members of different corridors. Based on the logic of the opportunity cost of holding money, the lower this cost, the more profitable India's trade with the target country becomes. This leads to a lower demand for money in India, subsequently causing less of an increase in interest rates and inflation. Therefore, understanding and managing the OC in international trade can significantly impact a country's economic health and trade efficiency. This also conveys a message that India's trade with the target countries can enhance macroeconomic target policies such as targeting inflation. Therefore, not only does the international trade improve in India, but it also follows macroeconomic policies, such as targeting inflation, that are vital to maintaining the purchasing power of Indian people.

Based on the points mentioned in the literature review section about the advantages of dynamic programming in a shopping time model and the data in Table 2, different service areas and distances result in varying OCs. This highlights the fact that unlike the gravity model in econometrics, which cannot provide the optimal policy, this method provides optimal amount of OC that leads policymakers in India to make the best decision for international trade policies.

There are two main ways to analyze the margin of error (OC) of countries in international trade. First, compare the average and standard deviation of each corridor. Second, compare the OC of each country in each corridor with the average OC of that corridor. According to the information in Table 2, it is evident that India, as a joint member of both corridors, will, on average, earn more benefits by trading with IMEEC compared to the INSTC countries. This is because the average and standard deviation of OC, calculated for each member country of the corridors, are lower in IMEEC countries compared to INSTC. When considering the OC of countries in each corridor, India's average OC for trade with IMEEC countries is 0.194, any amount lower than this would provide a better opportunity for trade. Therefore, India can benefit from trading with France, Italy, and especially the However, India's trade strategy should not exclude INSTC. Regarding INSTC, India can earn more benefits by trading with Russia and Kazakhstan, as the OC of trade with these countries is lower than the average trade in the corridor. Although the profitability of India and some other members in both corridors is high, the geopolitical, economic, and military conflicts among various countries slow the execution speed of INSTC, and the future of IMEEC remains highly uncertain. This highlights the importance of a diversified trade strategy that mitigates risks associated with geopolitical instability.

To support its international trade ambitions, India is enhancing its infrastructure. Initiatives aim to develop ports, highways, railways, and logistics hubs, thereby improving internal connectivity and trade efficiency. These efforts are crucial for integrating remote regions, supporting economic growth, and ensuring the seamless execution of India's grand strategy. Improved infrastructure not only facilitates smoother trade but also strengthens India's position in global trade networks.

Since the trade benefits vary, policymakers should establish a targeted policy for trading with countries that provide the most benefits. The findings recommend that policymakers in India prioritize trade with IMEEC members over INSTC members. This will help India boost private sector motivation to invest in ways that facilitate trade with IMEEC members. However, policymakers should also consider certain members of INSTC. The international trade policy aimed at enhancing corridors in India should focus on increasing trade with three European countries-France, Italy, and Russia–as well as Asian countries like the United Arab Emirates and Kazakhstan.

5.1. Limitations of the Study

This paper lists only those nations among the 13 INSTC member nations that share the Caspian Sea, including Russia, Azerbaijan, Iran, Kazakhstan, and Turkmenistan. Similarly, nations like the United Arab Emirates, Greece, France, and Italy that have ports connected to India's Vadhavan port are taken into consideration for IMEEC.

This paper only integrates physical distance and service area to create a distance index. However, geopolitical variables may also affect the index. Future research could potentially increase the number of member countries in both INSTC and IMEEC by exploring alternative transportation routes and new variables to expand the distance index. Future research should focus on refining methodologies, leveraging emerging technologies, and addressing the unique challenges of the Indian market.

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