Over-Agglomeration and Its Effects on Sustainable Development: A Case Study on Istanbul

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Abstract: Inequality, in any form and dimension, is a major damaging factor for sustainable development. One of the essential drivers of inequality is the over-agglomeration and congestion in a certain region. The reasons for the agglomeration are well documented, such as knowledge-spillovers, access to supply and demand markets, availability of skilled labor, and good infrastructure. However, over-agglomeration in a region, mainly triggered by poor planning and mismanagement of resource allocation, may also become a barrier for sustainable development. The over-agglomeration generally results in undesired negative effects impeding the economic, social, and environmental development any further, even causing irreversible social and environmental issues. Following the big-push model, a theoretical model is proposed to consider the negative effects of increasing rent prices due to over-agglomeration first on the industrial development of a country. This is then followed by a case study of Istanbul as a megacity and its effects on Turkey’s sustainable development through industrial, social, and ecological aspects. Istanbul has been the main industrial and economic center of Turkey as the city further expanded rapidly in the last 50 years in terms of population and urbanization. This over-agglomeration has resulted in very high rent prices in the city compared to the rest of Turkey, which affected the country’s industrialization. The over-agglomeration in Istanbul has also created significant economic imbalances and income-inequalities within the city and across Turkey. The environmental degradation, the loss of forest area, and very high air and noise pollution were other results of the city’s rapid expansion and over-agglomeration. These industrial, social, and environmental dynamics pose serious challenges to Turkey’s sustainable development as long as over-agglomeration in Istanbul persists or even aggravates further.

Keywords: sustainable development; over-agglomeration; industrialization; Istanbul

1. Introduction

Sustainable development has been initially defined as “meeting the needs of present without compromising the ability of future generations to meet their needs” by the Brundtland report published in 1987 [1]. Since then, the issue of sustainable development has increasingly attracted the attention of academia, international institutions, and multinational corporations [1]. There are three important pillars of sustainable development, which are the environment, economy, and society [2]. Fairness and equality in access to basic needs, such as housing, healthcare, security, clean water, and air; equality among genders and races in terms of income, justice, and rights; and preservation of the environment are among the main tenets of sustainable development [3,4]. As a result, equality is one of the most important drivers as well as an indicator of sustainable development [5]. Inequality of any form and dimension is known to be a major damaging factor for sustainable development [6]. Inequality due to structural issues is difficult to overcome and correct, which may hinder the sustainable development permanently [1]. For a given country or region, one of the essential drivers of inequality
is the over-agglomeration and congestion around a certain geographic location, such as a city [7]. This particular issue is more of a concern for the sustainable development in emerging economies due to the increasing number of megacities in those countries [8]. Initial benefits in agglomeration of resources into a certain region are generally outweighed by congestion, rising costs, and environmental degradation in the later stage [9].

Agglomeration or cluster economics has been an important research area in development studies since the 1970s. Transaction costs and knowledge spillovers are the key factors in the agglomeration and localization of certain industries in certain parts of a country and the world. By grouping together in close proximity, the firms in certain sectors are able to lower their transaction costs, such as labor and input materials, thanks to economies of scale [10]. Second, accumulated experience and tacit knowledge are dissipated much faster in local production groups that contribute to productivity significantly [11]. Finally, but not the least, the availability and abundance of skilled labor in the vicinity of the firms is another important factor gained by agglomeration or clustering [12]. All such positive factors and externalities have led to an agglomeration of economic and industrial activities in certain centers or regions across the world usually by market forces and natural clustering, but, increasingly, also by government planning and incentives.

Nonetheless, the rapid development coupled with the poor (lack of) resource management and economic planning have led to the problem of “over-agglomeration” in many developing countries, such as Brazil, Mexico, and India [13]. Over time, many cities in those countries have expanded well beyond their natural zones that resulted in over-agglomeration and congestion in terms of population, transportation, land use, economic activities, industrial production, and public services. Such over-agglomeration in a city eventually becomes a barrier for the sustainable development in the host country due to waste of limited resources, and economic and social inequality across the regions [8]. For example, an increasing population due to internal immigration to such over-agglomerated megacities necessitated increasing infrastructure needs in transportation, communication, education, healthcare, etc. This has resulted in a further increase in population to uncontrollable levels, and overall life quality for society and individuals is consequently diminished due to increasing congestion, traffic, and pollution [14]. In addition, land prices and other services have become increasingly costly in these areas and factored in production costs of industries in the forms of rental payments, transportation, and utility costs [15]. All these side effects of over-agglomeration and congestion in megacities pose significant challenges to sustainable development. Over-agglomeration in a megacity can also result in increasing crime rates, social exclusion, high unemployment levels, and deteriorating health services for a large section of the society [8].

A case study is then conducted on the effects of Istanbul being a megacity on the city’s industrialization through high rent prices as a result of the over-agglomeration and congestion. There have been a number of industrial sectors agglomerated in various parts of the city, which have over-expanded the city to its geographical borders. A significant amount of Turkey’s human capital and economic resources are over-agglomerated in Istanbul. This has resulted in significant economic imbalances both in terms of economic size, personal wealth, and income distribution. The city has both the highest personal wealth and income-inequality in Turkey at the same time. The poorest cities of Turkey have very high income-inequality by comparison with Istanbul. High costs of rent for both commercial and residential buildings are among the main recent culprits for the relatively decreasing role of industrial activity in the city. The city’s over-agglomeration and rapid expansion have also caused an environmental degradation in the form of lost forest area [16]. Furthermore, growing economic activity has resulted in an eight times faster growth in a number of motor vehicles than the population of Istanbul within the last 50 years [17]. As a result, widespread traffic congestions have become a critical and daily problem in every part of Istanbul due to insufficient investment and infrastructure in transportation to meet the demand of such rapid growth [17]. The city suffers heavily from noise pollution and subsequent hearing loss levels on its residents. Istanbul is among the worst cities when it comes to noise pollution and subsequent hearing loss problems as it is
ranked fifth out of 50 globally selected cities [18]. Moreover, significant lead times in the transportation of goods and labor are claimed to contribute to latent or even decreasing productivity levels in cases of over-agglomeration and congestion [19]. Istanbul is among the European cities with the highest air pollution due to road traffic as a result [20]. These three dynamics may play a significantly negative role in the sustainable development pattern of Turkey unless a course of actions is taken immediately.

Section 2 discusses the existing literature of industrialization and over agglomeration within the context of sustainable development. Section 3 lays out the Big Push Model’s revised version to study the trajectory of industrialization in the case of over-agglomeration. Section 4 discusses the case of Istanbul for over-agglomeration and its negative effects on sustainable development, whereas Section 5 gives the conclusions and discussions.

2. Over Agglomeration in Mega Cities and the Theory of Big Push for Industrialization

The size of a city is regarded as a tradeoff between increasing returns due to agglomeration economies and urban congestion [21]. The agglomeration of economic and industrial activities into a certain city occurs due to a myriad of reasons, such as labor and equipment pooling and access to technical skills, and benefitting from the knowledge spillovers. Furthermore, firms gain the advantage of sharing indivisible goods, accessing special inputs, and attenuating the risk of upfront investment [22,23]. Agglomeration of certain firms, industries, or sectors results in not just input variety and accessibility, but in the availability of various intermediate and final goods as well. As a result, the agents get the benefit of both the economies of scale and scope in the whole production process due to agglomeration [24].

The Big Push Theory has been developed to explain the industrialization dynamics of a developing country from the less-advanced to the advanced economy [25]. The main argument of this theory rests on the fact that a developing country may get stuck in a low level of economic advancement unless it overcomes the high initial cost of investment into certain industrialized sectors. The transition from backward production (constant returns to scale) to industrialized production (advanced and increasing returns to scale) requires a significant upfront investment cost, which may not be recovered if only a few sectors are industrialized [26]. When the initial investment cost for industrialized production is very high (precision equipment, sophisticated operating system, land, skilled labor), there may be no single firm taking such an investment due to insufficient demand and prospects of negative profits. However, when a certain number of firms invest in industrialized production simultaneously, there can be positive profits for each of these firms due to an overall expansion in the economy described as the “Big Push”. This occurs because implementing industrialized production across the whole economy creates demand externalities and enough economic expansion to overcome the initial investment cost by each individual factory production firm [25].

The existing literature has laid out well some reasons for under-industrialization in developing countries, such as the lack of an effective government support [27], inadequate physical and human capital [25], and the size of the domestic economy [15]. However, the role of inflated rent prices due to over-agglomeration has not been studied in detail both theoretically and empirically. This paper attempts to address this perceived gap in the literature of development economics by revisiting the Big Push Model from a rent perspective with a case study of Istanbul’s over-agglomeration. Furthermore, the analysis has been extended to the sustainable development aspects of over-agglomeration in a developing country. There are three pillars of sustainable development, which are economic equality, protection of the environment, and social justice [9]. There is a growing concern that over-agglomeration into certain megacities puts the sustainable development of a country in jeopardy due to economic imbalances across and within the regions, and rapid degradation in the environment as well as increasing pollution [28]. Megacities are growing in number and size across the world and especially in developing countries, which have resulted in serious economic, environmental, and social challenges [29,30]. Analyzing the relationship between the growth of megacities and sustainable development has become a critical subject from all aspects. This paper tries to address this challenge
by looking first into the relationship between over-agglomeration and industrialization dynamics with a theoretical analysis. The negative effects of over-agglomeration in a megacity have also been analyzed from an industrial, economic, social, and environmental perspective through a case study on the city of Istanbul.

3. A Model of the Big Push for Over-Agglomeration

3.1. Model Basics and Assumptions

The model developed in this section is based on the model of big-push developed by Murphy, Shleifer, and Vishny, denoted as the “MSV model” following the initials of its three authors [25]. As explained earlier, this model presumes that industrialization in a developing country may require a simultaneous push in different sectors at once due to high fixed costs. Acquiring production equipment and further upfront capital investment for technology makes industrialization a costly business for a developing country. Therefore, private agents may refrain from taking such an investment due to the concern of never recovering high initial costs in case of insufficient demand. In this instance, the country will be locked up into fringe (unindustrialized) production permanently. Indeed, this is a very likely scenario, which may prompt government intervention [27]. We, nonetheless, focus on not this initial lock-up or failure to industrialize, but the later stage of the process in a developing country. Basically, a model is developed to show that over-agglomeration and congestion in a megacity can stop or even reverse the industrialization trajectory of a developing country. The mechanism that this effect occurs through is the increasing of the fixed cost of industrialization due to high land, rent prices, and living and investment costs in a megacity.

In such a close and developing economy, there are K sectors in total, where N of them are produced by using advanced technology and the rest (K-N) are produced by fringe technology. Each sector produces a unique product, which has equal utility with other products from the consumer’s perspective. In each sector, there is either a fringe technology utilizing a firm, or advanced technology utilizing a monopolist firm. While fringe technology utilizing a firm has no significant upfront cost, it has also constant returns to scale production per worker employed. On the other hand, the switch to advanced technology by a firm requires significant upfront (fixed, sunk) cost while that technology provides increasing returns to scale production per worker employed. The assumptions below summarize the main working dynamics of the model for the industrialization pattern of a developing country inspired by the model of MSV.

The Model’s Assumptions

A1. Each sector has a fringe firm initially with a potential for an is be denoted by n, and hence the level of industrialization in a developing country is n/k.

A2. A fringe firm has the following production function: \( X_j = L_j \), where \( X \) represents the amount of output and \( L \) represents the number of labor used in sector \( j \). These firms are perfectly competitive and, hence, can enter or exit a sector freely depending on whether this sector is industrialized.

A3. A monopolist (advanced) firm has the following production function:

\[
X_a = \beta \cdot (L_a - F) \]

where \( X \) is the amount of output, \( \beta \) is technological parameter due to advanced utilization with it being greater than 1, \( L \) is the amount of labor, and \( F \) represents the fixed cost measured here through a unit of labor. It is very obvious that a monopolist firm gets more output per labor employed due to advanced technology utilization while incurring a fixed cost. A monopolist firm will enter a sector only if it makes a profit as opposed to a fringe firm, which has zero profit due to perfect competition from other fringe firms.

A4. Profit of an advanced firm \( (\pi_a) \) then becomes:
\[ \pi_a = X_a * I_a \text{, where } I_a = X_a / \beta + F \text{ from A3 and:} \]
\[ \pi_a = X_a * (1 - \frac{1 + \nu}{\beta}) - (1 + \nu) * F \]

We also assume that the productivity of labor in the advanced sector (\( \beta \)) is higher than his premium wage (1 + \( v \)), such that an advanced firm makes a profit by employing skilled labor: \( \beta > 1 + v \).

A5. The total number of labor available in the economy is denoted with the parameter, \( L \), and wages across fringe (unindustrialized) sectors assumed to be equal and normalized to 1 as a numeraire to simplify the analysis. On the other hand, wages in advanced sectors is higher than wages in fringe sectors due to the requirement for highly skilled workers, which dictates higher wages assumed to be 1 + \( v \).

A6. Products from each type of firm are almost similar in the sense that consumers will prefer the product of a monopolist firm over a fringe firm, but will not pay a higher price. Therefore, the fringe firm is the price setter in each sector. As a result, the price of each product is going to be equal to the wage of labor in the fringe sector due to the perfect competition assumption. Since we assumed wage equality across all the sectors, the price of each product will also be the same across each sector and equal to 1.

A7. A closed economy is assumed with no export, import, or capital movements to simplify the analysis following the literature of industrialization [27]. Consumers also do not save their earnings in the form of wages and spend on goods produced in each sector.

3.2. A Solution of the Model

The solution of the model starts with solving the consumer utilization problem to find the bundle of goods yielding the optimal utility based on the available budget and the price of each good. After finding the desired level of goods to be consumed by each consumer, the total consumption level comprising both products of the fringe and advanced production is calculated. The total value of the final consumption should be equal to the national output of the economy (Y) in a closed economy. The model does not incorporate savings for later periods and international trade (exports and imports). Thus, the final consumption by both private agents and labor is equal to the summation of their profits (agents in advanced production) and wages (labor). Once the national output level (Y) is calculated, the profit of each firm in advanced production (if there any) is calculated. The solution is then extended to the sensitivity analysis of profitability in advanced sectors depending on the fixed cost (F), size of the economy (Y), and productivity level (\( \beta \)) as well as the wage premium paid to labor in advanced sectors (\( v \)). The profitability of advanced sectors determines the final number of firms in advanced production (\( n^* \)) and hence the level of industrialization.

Consumers will maximize their utility by consuming a bundle of products produced across k sectors subject to their budgetary constraint:

Max Utility (\( U \)) = \( X_1 X_2 \ldots X_k \)  
Subject to: \( P_1 X_1 + P_2 X_2 + \ldots + P_k X_k = L * w \)

Since we assumed that \( P_1 = P_2 = \ldots = P_k \) and \( w = 1 \),

Taking the derivation of \( U \) with respect to the budget constraint yields, the following optimal consumption results:

\[ X_1^* / P_1 = X_2^* / P_2 = \ldots = X_k^* / P_k \]

Consumer utility (\( U \)) gets maximized when \( X_1 = X_2 = \ldots = X_k \) since prices are equal for each product:

\[ X_1^* = X_2^* = \ldots = X_k^* \]  

To find out how much total actual output there will be, we need to calculate how many sectors are industrialized (advanced) in the economy, which is denoted as “\( n^* \)” previously. The reason is that
advanced firms have increasing returns to scale, such that their output will be higher than the number of their employees. On the other hand, if there is no industrialization (n = 0), then fringe firms will produce an output equal to the total labor supply (L), and the size of the economy is:

\[ Y(n = 0) = L \] (3)

Since \( Y = \) Wage of total labor \((L \times 1 = L)\) + profit of fringe firms \((0)\) To find the demand for each product, \( X_1 + X_2 + \ldots + X_k = Y; X_i = Y/k = L/k \) for all i's.

When \( n > 0 \), there will be at least partial industrialization in the economy, and to find the total output:

\[ Y = \text{total wage in fringe sectors} \left(\frac{(k - n)}{k} * Y\right) + \text{total wage in advanced sectors} \left(\frac{L - (k - n)}{k} * Y\right) + \text{profit of fringe firms} (\text{equal to } 0) + \text{profit of advanced firms} (n \cdot \pi_a) \]

where we find the profit of advanced firms by using the equation from A4:

\[ \pi_a = X_a \cdot (1 - \frac{1 + \beta}{\alpha}) - (1 + \nu) \cdot F, \]

so \( Y \) becomes:

\[ Y = \frac{(k - n)}{k} * Y + (1 + v) * (L - \frac{(k - n)}{k} * Y) + n * (X_a * (1 - \frac{1 + \beta}{\alpha}) - (1 + v) * F) \]

where \( X_a = Y/k \) and assumes \( 1 - \frac{1 + \nu}{\alpha} = \alpha \) so that \( Y \) becomes:

\[ Y = \frac{(L - n \cdot F) \cdot k \cdot (1 + v)}{k \cdot (1 + v) - n * (\alpha + v)} \] (4)

Equation (4) shows the size of an economy with partial industrialization \((0 < n < k)\). It should be noted that \( L \gg n \cdot F \), especially for a large country, since \( L \) represents the total amount of labor in the economy. Therefore, the economy’s size \( (Y) \) grows with more industrialization \((\text{higher } n)\) as more value added has been created in the economy.

For such an industrialization to occur, the firms should take a decision to invest in industrialized technology. For this to happen, a single firm should be able to foresee a profit \((\pi_a \geq 0)\) even if there is no other firm willing to invest in industrialized production \((n = 1)\). The necessary level of fixed cost \( (F) \) for that profit level required must satisfy the following inequality:

\[ \pi_a = X_a \cdot \alpha - F \cdot (1 + \nu) \geq 0, \quad n = 1 \] (5)

when \( n = 1 \), the size of the economy \( (Y) \) becomes \( \frac{(L - F) \cdot k \cdot (1 + v)}{k \cdot (1 + v) - (\alpha + v)} \) after replacing \( n \) with 1 in Equation (4). We also know that \( X_a = Y/k \), which is equal to \( \frac{(L - F) \cdot k \cdot (1 + v)}{k \cdot (1 + v) - (\alpha + v)} \), and hence putting this into Equation (5) yields:

\[ \pi_a = \frac{(L - F_0) \cdot (1 + v)}{k \cdot (1 + v) - (\alpha + v)} \cdot \alpha - (1 + \nu) \cdot F_0 = 0 \]

\[ F_0 = \frac{L \cdot \alpha}{k \cdot (1 + v) - \nu} \]

\[ F \leq F_0 = \frac{L \cdot \alpha}{k \cdot (1 + v) - \nu} \] (6)

**Proposition 1.** Fixed cost \( (F) \) should be lower than the threshold fixed cost, \( (F_0 = \frac{L \cdot \alpha}{k \cdot (1 + v) - \nu}) \), in an economy to induce industrialization by the firms (a big push), where even a single firm will be induced to invest into industrialization production regardless of what other firms do. Hence, there will not be a possibility of coordination failure when the fixed cost \( (F) \) is so low and promising profits will push all agents simultaneously into industrialization similar to the findings of other studies [27]. We have also shown previously that higher
industrialization will lead to higher profits for the firms switching to advanced technology due to the growing size of the economy and subsequent demand for their products. The following graph shows the relationship between the profit per an advanced firm that switched to industrialized production ($\pi_a$) and the total number of the firms switched into industrialized production ($n$):

In such an economy, there is only one Nash equilibrium (point A in Figure 1) where all the firms switch into industrialized (advanced) production and all sectors (k) will be industrialized.

![Figure 1. Complete industrialization.](image)

For inequality to happen at Equation (6), which indicates the relatively low fixed cost of advanced production ($F < F_0$), either population should be very large ($L$) or the productivity of the advanced (industrialized) sector ($\beta$) must be high. When none of these is the case and the fixed cost has become bigger than the threshold fixed cost ($F > F_0$), a different dynamic in the industrialization pattern of the country emerges.

**Proposition 2.** In the case of very high fixed costs, no single firm can foresee a profit by switching into advanced production in which high upfront investment will not be compensated by insufficient demand. On the other hand, a simultaneous investment by a group of firms will expand the economy sufficiently, such that the high initial cost will not be an issue. For all practical purposes, let us assume the actual fixed cost, $F$, is higher than $F_0$ by a cost parameter, $C$:

$$F = C + F_0 = C + \frac{L \times \alpha}{k \times (1 + v) - (\alpha + v)}$$  \hspace{1cm} (7)

Based on the previous Equation (5), when there is only a single agent in an industrialized sector with a fixed cost ($F$) higher than the threshold fixed cost ($F_0$), its profits will be negative:

$$\pi_a = \frac{(L - F) \times (1 + v)}{k \times (1 + v) - (\alpha + v)} \times \alpha - (1 + v) \times (C + F_0) < 0, \quad n = 1$$  \hspace{1cm} (8)

In this case, no single firm will be willing to invest in the advanced technology knowing that his profits will be negative. However, if a certain number of firms invest in the advanced technologies at once, they can break even this high fixed cost ($F = c \times F_0$). Let denote threshold number of firms needed to invest into advanced sectors to break even as $n^*$ such that:

$$\pi_a = \frac{(L - n^* \times F) \times (1 + v)}{k \times (1 + v) - n^* \times (\alpha + v)} \times \alpha - (1 + v) \times (C + F_0) = 0, \quad n = n^*.$$  \hspace{1cm} (9)
At industrialization level of \( n = n^* \), the size of the economy will become
\[
Y = \left( \frac{L - n^* \cdot F}{k \cdot (1 + v)} \right) \ast k \cdot (1 + v) \ast \alpha - (1 + v) \ast (F) = 0,
\]
and the firms can break even if they switch to advanced technologies by overcoming high fixed costs
\( F \). Solving the equality at 9 yields the value of \( n^* \) as:
\[
\frac{(L - F) \ast (1 + v)}{k \cdot (1 + v) - (\alpha + v)} \ast \alpha - (1 + v) \ast (F) = 0,
\]
which becomes the following:
\[
\frac{(L - n^* \cdot (C + \frac{L \cdot \alpha}{k \cdot (1 + v) - v})) \ast (1 + v)}{k \cdot (1 + v) - n^* \cdot (\alpha + v)} \ast \alpha - (C + \frac{L \cdot \alpha}{k \cdot (1 + v) - v}) = 0
\]
From Equation (10), after cancelling out same terms from both sides and subsequent simplification, it yields:
\[
n^* = \left( \frac{C + \frac{L \cdot \alpha}{k \cdot (1 + v) - v}}{(1 - \alpha) \ast v \ast (C + \frac{L \cdot \alpha}{k \cdot (1 + v) - v})} \right)
\]
where \( n^* \) becomes the following after simplifying the term above:
\[
n^* = \frac{(C - L \ast \alpha) \ast (k \ast (1 + v) - v) + L \ast \alpha) \ast (1 + v)}{(C \ast (k \ast (1 + v) - v)) + L \ast \alpha) \ast (1 - \alpha) \ast v}
\]
Figure 2 shows the relationship between the profit per an advanced firm that switched to industrialized production (\( \pi_a \)) and the total number of the firms switched into industrialized production (\( n \)) when the actual fixed cost is greater than the threshold fixed cost (\( F > F_0 \)).

When fixed costs are too high, no single firm can break even alone in entering advanced production where its profits will be negative. However, if a certain number of firms (\( n^* \)) enter into advanced production simultaneously, named as the big-push, they will break even due to sufficient growth and subsequent demand in the economy. There are two important points to be discussed in this context of big-push industrialization dynamics. It is very difficult for firms to coordinate their actions simultaneously considering the whole economy and involved firms for entering advanced production when fixed costs are too high. This problem is called a “collective action” problem in the development of economic literature [27,31]. For that specific reason, some scholars argue whether the state itself should take action by either entering into advanced production or subsidizing firms to do so [13,27].
Secondly, if a sufficient number of firms (n*) invests into advanced production and breaks even, then other firms will follow and the country will get industrialized fully. Therefore, points A and B in graph 2 are both Nash equilibria and a number of factors could dictate in which a developing country will settle.

3.3. A Modification to the Model Based on the Dynamics of a Developing Country

In the previous section, the fixed costs (F) of a firm switching to advanced production was assumed to be static irrespective of industrialization dynamics of the country. Many initial expenditures for setting up an advanced production are bundled into this fixed cost in the analysis above. These expenditures are mainly capital equipment, technology acquisition, and physical facilities along with the land [25]. However, that fixed cost may change and behave in a dynamic pattern in the case of over-agglomeration and congestion [15]. This may impede the industrialization dynamics of the particular country.

It is very probable that once a city reaches its natural borders due to economic activity and expansion, rent prices may start increasing rapidly. This may then make an initial investment into new (industrialized) production costlier compared to the previous case. The increase in cost would not just be an increase in the land price of the production facility, but the cost of all other services (labor and capital) due to congestion in the city. Indeed, this phenomenon has been observed in many developing countries where over-agglomeration and congestion have finally put a dent in the respective city’s industrialization and multi-dimensional sustainable development [32]. Oh (2008) analyzed the effect of congestion on the increase in fixed costs through an increase in labor cost. However, the increased cost of labor due to congestion should not just be represented in the fixed cost of labor, but the overall cost, if it is very important.

We take these factors into consideration and propose a newly fixed cost equation while realizing the positive and negative effects of agglomeration simultaneously. In an earlier phase of industrialization, agglomeration of the advanced firms in the same geographic region reduces fixed costs due to easy access to initial labor and a facility site for establishing the production plant or factory [13,27,32]. A firm switching to advanced production would find it easier in access to manufacturing equipment and know-how needed to run the factory in a cluster with the same firms. Specifically, the local or regional governments may also propose incentives for the firms utilizing advanced production in certain locations to attract more firms. This may further decrease the fixed costs of a firm investing in advanced production. However, these kinds of government support are usually phased out once a certain number of firms have switched and the target is met [33].

Once a region has reached its natural geographical limits for industrialization due to agglomeration and clustering of the firms, costs will start increasing rapidly. Land prices will go up for both factory locations and housing of labor. Logistics will become more expensive for transportation of goods, equipment, and labor [15] in addition to the gradual decrease of life quality that will adversely affect further attraction of a skillful workforce. Therefore, the positive benefits of agglomeration will be outweighed by congestion and rapid increases in the cost of doing business, especially those fixed costs. As indicated earlier, a firm usually makes its investment decision irrespective of other firms, and over-agglomeration and congestion generally occur in many industrialized regions of the countries globally [32]. While the current literature has documented well the negative effects of over-agglomeration and congestion on the cost of labor and productivity [15], highly increased land prices and its negative effects on further industrialization are ignored.

A modification to the fixed cost (F) has been proposed below to explain this phenomenon theoretically in industrialization dynamics of a developing country. We assume a similarly high fixed cost in Proposition 2 (F = C + F₀) initially when there is no firm industrialized (n = 0). However, this high cost starts decreasing by the number of firms switching to industrialized production until agglomeration in a certain region has reached a tipping point. Let us assume that this tipping point is the same number of firms found in Equation (12), where the firms break even at a high fixed
cost of $F$ that is $n = n^*$. The inequality below shows the new dynamic fixed cost for an industrializing region that is still under the threshold industrialization level:

$$F_n = \frac{k - n}{k} * (C + F_0) \text{ for } n \leq n^*$$

(12)

It is very obvious that $\frac{\partial F_n}{\partial n} < - \frac{1}{k} * (C + F_0) < 0$, which means that the more firms that are switching to industrialized production, the less the fixed cost for those firms will become. In a similar fashion, once the number of firms reaching $n = n^*$, then the fixed cost will start increasing accordingly:

$$F_n = \frac{k - n^*}{n^*} * \frac{n}{k} * (C + F_0) \text{ for } n \leq n^*$$

(13)

It is very obvious that $\frac{\partial F_n}{\partial n} < \frac{k - n^*}{n^*} * \frac{1}{k} * (C + F_0) > 0$, which means that the more firms that are switching to industrialized production, the more the fixed cost for those firms will become once a threshold level ($n^*$) is passed. Figure 3 shows the new profitability and industrialization dynamics of the region with new fixed cost assumed in Inequalities (12) and (13) above.

Figure 3 illustrates the new dynamics of industrialization in a region of a developing country after taking the dynamic nature of fixed cost into account. We assumed the same initial fixed cost, such as in Proposition 2, where a single firm does not break even by switching to advanced production alone. This refers to point A in Figure 3 and unless a group of firms moves simultaneously, the region or even the country may get stuck in a permanent backward economy with no industrialization. It is one of the Nash equilibria in this case since no firm will change its decision (whether to switch to advanced production) if no any other firm changes its decision.

Once a sufficient number of firms collaborate to invest into industrialized production simultaneously or the government takes the initiative [27], then there will be a break even and the potential of profit for firms switching to advanced production. A number of firms needed to break even ($n$) are less than the number of firms needed to break even in graph 2 ($n^*$), since the fixed cost ($F$) decreases with more firms switching to advanced production. However, neither point B or C are in Nash-equilibrium because backward production firms will follow the advanced firms due to the
prospects of higher profits. The switch of more firms into advanced production will increase the profits until point C due to positive externalities and the decreasing fixed costs effect. Profit per the advanced firm will reach a maximum when there is exactly $n^*$ firms in industrial production. However, more firms will enter advanced production at point C in Figure 3 due to profits and free entry into the market as assumed earlier. Firms will keep switching to advanced production until profits become zero, which is marked as point D in Figure 3. At this point, no single firm will be enticed to enter advanced production since profits are zero. This point is also a Nash-equilibrium, since no firm will change its position unless another firm changes its position. The most important point to be noted here is that industrialization of the country will be below full industrialization ($n < k$) at point D due to over-agglomeration and congestion. Therefore, the country will not live up to its potential under increasing fixed costs as opposed to the case of fixed costs in Proposition 2.

4. Over-Agglomeration in Istanbul and Effects on Turkey’s Industrialization

Istanbul city has been the main economic, industrial, and cultural center of Turkey for decades. The city’s famous history precedes the current developing country of Turkey by a great margin as it had been home to the Eastern Rome Empire and Ottoman Empire. The city has been strategically located in the northwestern region of the Anatolian peninsula (Asian side) with an equal sized section in the European side. The city’s geographical land size is around 5000 km$^2$, which is less than 1% of Turkey’s total land area. While the city occupies less than 1% of the total land area of Turkey, it is home to 18.5% of the total population of the country. The city has 27 times of the average population density of Turkey. The city also hosts the highly strategic Bosporus Strait, which is the only gate to the Black sea (Figure 4). The city’s historical and geographical importance is coupled further with its beautiful nature that hosts various lakes and forests. As a result, this splendid city has been the crown jewel of the Turkish Republic similar to preceding empires. The city is a magnet for tourists, businessmen, labor, craftsmen, and so many others, who have made it one of the megacities of the 21st century.

![Geographical location and size of Istanbul (blue) in Turkey’s city map (Tuik.gov).](image)

Due to its favorable geographic location, the positioning of Turkish capital class, support of the state in the forms of infrastructure, and industrial investments, Istanbul has been the economic center of modern Turkey in an increasing capacity [34]. Especially since World War II, there has been a constant inward immigration towards Istanbul from all other parts of Turkey that has not stopped in the 21st century [35]. As a result, the frontiers of the city have kept growing and stretched to Istanbul’s borders from almost all directions, also with an increasing rate [36]. Figure 5 shows the rapid
increase in Istanbul’s population and its share in Turkey’s total population, which have both increased continuously in the last 65 years. This huge growth in population has actually been spurred by the rapidly growing economic activity in Istanbul that has acted as a magnet for people from the rest of the Turkey [34]. Istanbul is roughly responsible for a one third of Turkey’s total economic activity, especially for industrial and services sectors, as shown in Figure 6.

![Graph of Istanbul Population and Share in Turkey's GDP](image)

**Figure 5.** Istanbul’s total population and its share in Turkey’s population (TUIK, 2018).

**Figure 6.** Istanbul’s share in Turkey’s economy by sectors, 2014 (TUIK).

Considering its vast infrastructure and highly developed supply chain system, it is no coincidence that Istanbul has been the epicenter of industrial, economic, social, and cultural agglomeration journey of Turkey [37]. Istanbul has actually been the engine of economic and social activity of the surrounding regions, such as the Anatolian peninsula, for centuries. As discussed earlier, its strategic location has given the city an immense advantage for attracting business activity, which has never ceased in both the Ottoman Empire and the Turkish Republic. An important reason for agglomeration in a megacity is the variety of indivisible private and public goods that serve a benefit to all the agents in that city [21]. Istanbul has a significant advantage in that regard, since a significant size of the infrastructure and social investments have been undertaken within the vicinity of the city [38]. Table 1 briefly summarizes
the number of units of indivisible goods in the city of Istanbul and its share in Turkey’s total in addition to the fact that it is home to around 15 million people as residents and around 20 million transiting or conducting business in any given day (19% and 25% of the overall population, respectively).

**Table 1.** List of selected indivisible goods in Istanbul and its share in Turkey.

<table>
<thead>
<tr>
<th>Indivisible Goods and Services</th>
<th>Total Number in Istanbul</th>
<th>As a % of Total in Turkey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bank Branches</td>
<td>1730</td>
<td>29.00%</td>
</tr>
<tr>
<td>Commercial Firms</td>
<td>270,000</td>
<td>29.50%</td>
</tr>
<tr>
<td>Number of Universities</td>
<td>51</td>
<td>30.00%</td>
</tr>
<tr>
<td>Number of Hospitals</td>
<td>233</td>
<td>26.60%</td>
</tr>
<tr>
<td>Number of Art Galleries</td>
<td>68</td>
<td>23.13%</td>
</tr>
<tr>
<td>Number of Stadiums</td>
<td>27</td>
<td>19.29%</td>
</tr>
<tr>
<td>Freight Volume Capacity (tons)</td>
<td>6 million</td>
<td>32.43%</td>
</tr>
</tbody>
</table>

Furthermore, the Turkish government continues to gravitate most of the significant infrastructure investments towards Istanbul and its close vicinity, which further increases the agglomeration of the city. Table 2 highlights the current major infrastructure spending in Turkey, where Istanbul holds a lion share [39].

**Table 2.** Current major infrastructure spending in Istanbul and Turkey.

| Current Large-Scale Infrastructure Projects in Istanbul and the Rest of Turkey |
|---------------------------------|----------------------|------------------|---|
| Name of the Project            | The value in USD Billion | As a Percentage | Region |
| Third Bosporus Bridge           | 3.40                 | 57.98%           | Istanbul |
| Istanbul Third Bridge Connection Roads | 2.70             |                  |        |
| Third Istanbul Airport          | 6.90                 |                  |        |
| Istanbul Big Tunnel             | 3.50                 |                  |        |
| Istanbul Eurasia Tunnel         | 1.20                 |                  |        |
| Istanbul-Ankara High-Speed Railway | 3.00            |                  |        |
| Gebze-Izmir Highway            | 6.30                 |                  |        |
| Ankara-Nigde Motorway          | 1.50                 | 42.02%           | Rest of Turkey |
| Ankara-Sivas High-Speed Railway | 1.20                |                  |        |
| Dardanelles Bridge and Motorway | 6.00                |                  |        |
| **Total**                      | **35.70**            | **100.00%**      | **Total** |

As a result, Istanbul has become a poly-centric city and home to various industrial clusters specialized in different products and services as a heart of the Turkish economy [23]. Figure 7 lists the industrial sectors where there is an agglomeration in the Istanbul metropolitan area (IMA) based on the Ellison Glaeser index (EGI) [23].

The EGI shows how much a sector or industry has been localized geographically by calculating each plant’s employment geographic pattern [23]. The EGI can take values between zero and one. While a zero EGI means no geographical agglomeration of the given industry or sector, complete agglomeration refers to the value of 1 for the EGI. It is straightforward to conclude that Istanbul has been the industrial center of various sectors with strong agglomeration. The city has been the center of the Turkish industry by accommodating various sectors in certain industrial clusters. Istanbul is a polycentric city regarding industrial agglomeration as it is home to various industrial clusters scattered throughout the city.
Land prices across Istanbul are at minimum twice of the other regions in Turkey, a pattern which is not so different in the industrial and business sectors as well [41]. Transportation time and costs, services, and utility costs have also increased rapidly in Istanbul due to the over-agglomeration and congestion [42]. This has led to exclusion of some sectors from the city to its periphery while some new sectors have emerged [42]. However, the transfer of some industrial activity has accelerated from Istanbul metropolitan area while the share of service sectors increased further in the city’s Gross Domestic Production (GDP). Figure 9 illustrates this transformation regarding the structural shift between industrial and service sectors in the size of Istanbul’s GDP.

There are ample reasons for such a decreasing role of industrial sectors in Istanbul’s GDP. The increased cost of land is among the primary reasons both from an investment and labor perspective. Rising land prices drive up the cost of initial investment for land and cost of labor due to higher compensation required for increased cost of living [38]. The municipal authority of Istanbul and other numerous governmental organizations are fully aware of this fact and have tried to deindustrialize.
Domestic Production (GDP). Figure 9 illustrates this transformation regarding the structural shift between industrial and service sectors in the size of Istanbul’s GDP.

Figure 9. Change in Istanbul’s economic structure between 2004–2014 (TUIK).

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The over-agglomeration in the city of Istanbul has also caused environmental and further socio-economic problems in Turkey apart from the relatively low level of industrialization. The forest areas of Istanbul have been continually usurped and turned into residential, commercial, and industrial land plots for the last 50 years [43]. This has resulted in significant loss of wildlife and flora and decreases in the air, water, and soil qualities in the city [44]. The city had expanded its borders more than 80% within the last two decades of the 20th century, associated with a significant loss in the forest area [16]. Figure 10 shows the rapid conversion of forest area into man-made structures in the city of Istanbul, which heavily coincides with the over-agglomeration through time. Istanbul has also the worst air quality among the largest European cities due to pollution from heavy traffic and other industrial activities [45]. Large concentrations of particulate matters (PM), sulfur dioxide (SO₂), and nitrogen oxide compounds (NOₓ) cause various respiratory and cardiovascular diseases as well as a very high number of premature deaths [20]. Over-agglomeration and congestion cause very common and ubiquitous traffic jams across the city that cause more than 6 billion Turkish Liras annually based on some research [46]. These traffic jams have become a critical and very time-consuming problem in every part of Istanbul due to insufficient infrastructure to meet the demand from such a rapid growth [17]. In addition to air pollution and loss of forest area, Istanbul heavily suffers from noise pollution and subsequent hearing loss on its residents. Heavy traffic due to transportation (air, land, rail, sea), industrial and construction activities, and other human activities causes significant noise pollution in Istanbul. Figure 11 highlights this fact as Istanbul is among the worst cities when it comes to noise pollution and subsequent hearing loss problems as it is ranked fifth out of 50 globally selected cities [18].
Figure 10. Change of Istanbul’s landscape by time [43].

Figure 11. Noise pollution and hearing loss index [18].
In addition to the environmental degradation and destruction of the natural habitat, the over-agglomeration in Istanbul has caused general economic imbalances and inequalities across Turkey [37]. It is a well-known fact that Istanbul has acted as a magnet for both population and capital from the other regions of Turkey since 1950 [47]. Figure 5 points out the same dynamic as Istanbul’s share in Turkey’s total population has grown consistently over time while firmly cementing its dominance in economic activities. This has resulted in great income disparities across Turkey in terms of GDP per capita, where Istanbul and neighboring cities have much higher income levels compared to the rest of Turkey as shown in Figure 12.

This great economic imbalance between the periphery of Istanbul and the rest of Turkey, especially the south-eastern region, has resulted in greater income-inequalities across Turkey. Surprisingly, Istanbul has also the highest income-inequality measured by the Gini coefficient while being the richest city in Turkey. The south-eastern region of Turkey with the lowest income levels closely follows Istanbul when it comes to income-inequality, which is shown in Figure 13. Among the Organization for Economic Cooperation and Development Countries (OECD), Iceland has a Gini score of 0.25 as being the least inequal, and South Africa has a Gini score of 0.62 as being the most unequal in terms of income distribution. Turkey has been ranked as the sixth worst income-inequality country among the all OECD countries [48]. Over-agglomerated Istanbul and subsequently the less-developed south-eastern region of Turkey are among the main culprits of the high-income-inequality level of Turkey, which is among the highest across the OECD countries [49].
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Figure 13. Income-inequality across Turkish Cities measured by the Gini coefficient (tuik.gov.tr).

5. Conclusions and Remarks

Sustainable development of a region heavily depends on overall equality among the populace in the form of economic, social, and environmental dimensions [5]. Inequality of any form and dimension is known to be a major damaging factor for sustainable development [6]. One of the essential drivers of inequality is the over-agglomeration and congestion around a certain section or city [7]. The sustainable development of emerging economies is particularly prone to a high level of over-agglomeration due to megacities [8]. Initial benefits in agglomeration of resources into a certain region are generally outweighed by congestion, rising costs, and environmental degradation, with numerous examples worldwide [9].

The benefits of agglomeration and industrial clustering have been discussed and documented by numerous scholars [10,23]. Agglomeration of certain sectors in a geographical area offers easy access to a large pool of labor, capital equipment and maintenance, and intermediate products for the firms. A further benefit of agglomeration is a spillover of tacit knowledge and expertise among the participating firms, which is crucial for a competitive advantage [11,33]. Additionally, developing countries need a certain threshold for industrialization due to insufficient initial demand and expectations of negative profits by the firms willing to switch into advanced or industrial production. It has been argued by the big push theory that at least a certain amount of firms must switch simultaneously to the industrial production for those firms to break even and facilitate further industrialization as a result [15,25,50].

A theoretical model of the big push theory was revisited in that regard in Section 3. Conditions for a complete industrialization in a developing country were studied. Similar to previous works, it was shown that the initial fixed cost (F) is among the most important factors in the industrialization process of a developing country. If there are no sufficient firms willing to take an investment into advanced (industrialized) production simultaneously, then the country may get trapped permanently in a backward economy. Once a sufficient number of firms manage to invest in industrialized production and expand the overall economy as a result, there will be profit in industrialization for all the firms involved. This will result in the big push for the developing country as all the sectors will get switched into industrialized production. However, one crucial aspect of these dynamics is the assumption of a constant fixed cost in response to the level of industrialization. Empirical evidence suggests that this is not the case for most of the time following the analysis of the industrialization
patterns in many developing countries [15]. Fixed costs increase with more agglomeration and start outweighing the benefits of industrialization in the case of congestion through an increase in labor costs or decreasing productivity [15].

This paper adds to the literature by considering the relationship between the level of agglomeration and fixed costs through land prices, which are among the key reasons for the high costs of doing business [38]. A positive relationship with fixed costs and level of agglomeration may result in sub-optimal industrialization or reversal of the industrialization process. Benefits of further industrialization may be outweighed by the cost of land prices, which affect fixed costs dramatically in the case of over-agglomeration and congestion in a specific geographic area.

A special case study of over-agglomeration and congestion was analyzed for the city of Istanbul. There have been numerous industrial sectors agglomerated in various parts of the city, expanding to its geographical borders. Due to its favorable geographic location, and the continuous support of the successive Turkish governments in the forms of infrastructure and industrial investments, Istanbul has been the economic center of modern Turkey since its independence [34]. The constant inward immigration towards Istanbul from all other parts of Turkey have continued well into the 21st century [35]. As a result, the frontiers of the city have continued to grow and have stretched to Istanbul’s borders from almost all directions with an increasing rate [36]. However, the relative role of industrial sectors vis-à-vis service sectors has been decreasing in Istanbul over the last decade. There are ample reasons for such a decreasing role of industrial sectors in the Istanbul’s GDP. Very high costs of land for both residential and commercial purposes are among the primary reasons both from an investment and labor costs perspective. Rising land prices drive up the cost of initial investment due to an increasing cost of land and cost of labor [38]. The municipal authority of Istanbul and other numerous governmental organizations are fully aware of this fact and have tried to deindustrialize Istanbul and increase its services and tourism capacity [36,38].

Over-agglomeration has also caused environmental problems within Istanbul and across Turkey, impeding the sustainable development of the country further. There has been significant loss of forest area in Istanbul due to rapid expansion in all types of construction for the last 50 years. Figure 10 clearly illustrates the expansion of the city at a big cost to Istanbul’s vast forest lands and inevitable destruction of wildlife and deterioration in the environment of the city [43]. The loss of natural habitat and forestry has been further aggravated by the worsening air quality and increasing pollution due to heavy traffic and industrial activity in the city. Istanbul is consistently among the worst European cities for dangerous matters in the air, such as particulate matters, SO₂, and NOₓ, based on numerous studies [20]. The common and ubiquitous traffic jams also cause a loss of productive time and significant money due to insufficient infrastructure [17]. The city is also ranked as the fifth worst city out of 50 globally selected cities when it comes to noise pollution and subsequent hearing loss effects on its citizens [18].

There is a large income differential (measured by GDP per capita) across Turkey that is positively skewed towards Istanbul and its vicinity as shown in Figure 12. This income differential across the cities of Turkey manifests itself in economic inequality as well. While being the richest city in Turkey in terms of GDP per capita, Istanbul has also the highest internal income-inequality, which is followed by the poorest south-eastern region of Turkey. The land price disparity across all of Turkey is also another direct result of over-agglomeration and congestion in Istanbul. This may further impede the industrialization of Turkey into advanced production while causing economic imbalances across the country. Such large economic imbalances and ubiquitous income-inequalities may block sustainable development. Other studies also indicate that high rental income and land prices in over-agglomerated Istanbul are among the key reasons for income-inequality in Turkey as shown in Figure 14 [51].
From Turkey’s perspective, the wisdom of hoarding a significant size of its resources into a single city should be questioned. All the negative outcomes of the over-population in Istanbul have been known to the governmental bodies of Turkey at least in opaque terms [52]. However, the weak institutional structure of Turkey for property rights and environmental protection has been abused by the local municipal authorities in Istanbul in the form of illegal settlement and extension of the city’s borders [52,53]. Regardless of their ideological or lifestyle differences, almost all the political parties have seen the inward migration to Istanbul from other parts of Turkey as a base of support and hence actively encouraged the city’s expansion [52]. This political dynamic has contributed significantly to the over-agglomeration of Istanbul apart from the positive factors, such as labor pooling, access to capital and equipment goods, economies of scale and scope, and a large market for goods and services. As shown in Table 2, Istanbul continues to receive the lion’s share in current large infrastructure projects in Turkey. This will most probably increase further agglomeration of overall economic activity in Istanbul and aggravate further the economic, social, and environmental problems there.

This study is a prelude to understanding the relationship between over-agglomeration and sub-optimal industrialization due to rapidly increasing land costs in a specific geographic area, such as a city or region. Over-agglomeration and congestion cause numerous problems for the industrialization dynamics of a developing country. The decrease in productivity levels of labor, increasing cost of living standards, and hence labor costs, and logistical difficulties in moving goods and products are also side effects of over-agglomeration and congestion [15]. It is very probable that the decrease in Istanbul’s industrialization level may be partly attributed to some other factors as well, which we did not consider in this study. The theoretical model presented in this paper does not cover all the negative dynamics of sustainable development as a result of the over-agglomeration. Further theoretical analysis and case studies are needed to have a better understanding of the over-agglomeration and the trajectory of sustainable development. This paper does not argue that service sectors are less important than industrial sectors. Therefore, the increasing role of service sectors in Istanbul could add overall benefits to Turkey’s economy since some of these sectors can also show increasing returns to a scale pattern [54].

The prevalence of a megacity and subsequent problems in sustainable development are similar in other emerging economies, such as Brazil and India [8]. The majority of megacities in the world are located in developing countries, from Mexico to Indonesia [8]. The problems discussed in the context of Istanbul are not dissimilar to the problems faced by Mexico City, Sao Paolo, or Delhi [9]. Rapid economic development in many developing countries has resulted in entrenchment and dominance of megacities, which may further hamper sustainable development [55]. A better
understanding of the economic and political factors leading to over-agglomeration in a megacity is a must to come up with effective policy suggestions in the future not just for Turkey, but for other developing countries as well.

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