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Determinants for telecommunications investment in Latin America

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Abstract

The main objective of this paper is to analyze how the regulatory and institutional elements are related to the levels of investment in telecommunications infrastructure in Latin America. The results show that strict regulatory frameworks with strong obligations on operators seem to be related with lower investment intensity in network deployments. In addition, when there is an independent regulator, autonomous in decision-making and there is a competition authority, investments in the region seem to be larger. Finally, it was found that the institutions of a country are positively associated with investment decisions in the telecommunications sector. However, these results are preliminary, as further research will have to control for possible endogeneity concerns in order to make deductions on the causality of these effects. In any case, should these results be confirmed through further checks, this will provide evidence on the need for those responsible for regulatory decisions to promote more flexible approaches, prioritizing deregulation and self-regulation mechanisms when these are necessary. Likewise, this must be accompanied with an independent and autonomous regulator and a suitable competition authority. Additionally, it is necessary to strengthen the quality of national institutions in order to facilitate investments in the deployment of infrastructure.

JEL classification: D02, L51, L96

Keywords: Investment, Institutions, Regulation, Telecommunications

1. Introduction

At the end of the 20th century and the beginning of the 21st century, telecommunications began to revolutionize all aspects of modern life, from regular communications to business processes, and the network infrastructure is the core where the digital world is being built, which is leveraging productivity in every country in the world. Diverse studies have found a positive and strong relationship between telecommunications penetration and economic growth (see for instance, Röller & Waverman, 2001; Waverman, Meschi, & Fuss, 2005; Sridhar & Sridhar, 2008; Batuo, 2015). In fact, Huawei & Oxford Economics (2018) estimate that every dollar invested in digital technologies has a multiplier effect of 20 dollars in GDP, 6.7 times more than non-digital investments that barely add 3 dollars to GDP.

It is particularly relevant for a region such as Latin America that still has service penetration rates that are lower than those presented by, for example, OECD countries. Then, it is essential to understand which are main drivers of investment decisions in telecommunications, specifically from the regulatory and institutional point of view, to generate recommendations for regulatory policy and institutional changes that help close the digital divide that presents Latin America.

Several investigations have addressed the determinants of investment in telecommunications, some have focused on the role of the regulation (Gentzoglanis, 2004; Alesina, Ardagna, Nicoletti, & Schiantarelli, 2005; Cave, 2006; Bacache, Bourreau, & Gaudin, 2014, for example) and some others on institutions (Oxley & Yeung, 2001; Haggard, MacIntyre, & Tiede, 2008; Jerbashian & Kochanova, 2016, among others). However, there is a lack of studies that jointly address these two factors for Latin America, so it is still uncertain which are the most crucial elements to promote the deployment of telecommunications networks in the countries of the region.

The rest of the document is structured as follows. The second section presents a literature review on those researches that have studied or evaluated the relationship between regulation, institutions and investment. The third part shows the theoretical model that will serve as a basis to analyze the determinants of investment. The fourth is devoted to describing the data that will be used for the empirical analysis. The results of the estimations are collected in the fifth section. Finally, the sixth section shows the conclusions of the research and makes a series of recommendations to promote the development of telecommunications infrastructure in Latin America.

2. Literature Review

Investment is one of the key elements in the economy as it increases capital stocks, which in turn, fosters economic growth in the long-run. As a result, the analysis of investment drivers has attracted considerable attention of the economic literature. For a long time, the key determinants of investment decisions in the economy have been examined both at a theoretical and empirical level (see for instance Griliches, & Wallace, 1965; or Bernanke, 1983; among many others).

The telecommunications sector is by its own nature a capital-intensive industry, due to the large investment amounts that firms must make in order to deploy networks and take advantage of economies of scale. The reason behind this statement are the large fixed and sunk costs involved, which explain why, in the beginning, telecommunications were born as natural monopolies provided by the government.

However, only a couple of decades ago there was an explosion of research in the telecommunications sector, and specifically on the factors that affect investment levels. Due to the evolution of telecommunications, which have gone from structures of state monopolies to private monopolies and then to competing markets, most of research has focused on the effects of regulation over investment.

According to Gentzoglanis (2004), regulatory frameworks have an important influence on the structure of cost of capital and, consequently, on investment decisions. In fact, a large part of the increase in the price volatility of the telecommunications industry is due to structural changes in regulatory regimes given that companies must internalize regulatory risks within the total risks they face.

Alesina et al (2005), through a seminal paper which studied the impact of regulation intensity on investment decisions in public services, are one of the main contributions to the debate, finding that deregulation processes entail increases in investment in the long term, equally, liberalization of entry and privatization of firms have positive impacts on investment. The main transmission channels are the effects that regulatory reforms have on the margin of prices over costs, due to a reduction in barriers to entry; the influence that regulation has on the administrative costs ("red-tape costs" or other kind of regulatory burden) that firms face and that reduce the ability to adjust the stock of capital when market conditions change; and the inefficient demand for capital with respect to labor when regulating the threshold of the rate of return on capital.

It is also possible to find studies that argue positive effects of investment regulation. Cave (2006) states that by providing access opportunities to entrants to the infrastructure of the established ones it is possible to make the former jump through the investment ladder, generating competition for infrastructures.

However, there is empirical evidence that refutes the hypothesis of Cave (2006). Bacache, Bourreau & Gaudin (2014), for example, found that for a sample of 15 European countries there is no empirical evidence to prove this hypothesis for the transition from local loop unbundling to new access infrastructures.

Equally, Friederiszick et al (2008) studied the relationship between access regulations, like unbundling obligations, and investments in 25 European countries, finding that strong access regulations discourage investment in inbound operators for fixed services due to the reduction in incentives they have to deploy their own infrastructure in the long term.

Similar results are found analyzing whether access regulation impairs the incentives to deploy networks, which Grajek & Röller (2009) found when studying a sample of 20 European Union countries.

After that, Kim et al (2011) use a panel of 21 OECD countries to examine whether the regulation of MVNO and access has any effect on the investment levels of network operators, finding that the mandatory provision of access is related to less intensity in the deployment of networks, while the voluntary has no effect.

The same results were found in the United Kingdom when analyzing deregulation processes in the wholesale broadband access market (see Fabritz & Falck, 2013). Likewise, in the United States with more sophisticated and competitive markets, most recently literature suggests that the effects of regulatory intervention may be large, especially when they are given after a long process of deregulation, as had occurred in the American Internet market (Ford, 2018).

Further, institutions are another factor that may affect resources to grow the capital. Henisz and Zelner (2001) emphasize that investments in telecommunications are characterized by their high risk of expropriation, usually due to their sunk costs, where politicians have incentives to intervene in downward prices once the network has been deployed.

Oxley & Yeung (2001) argue that the rule of law has direct and indirect effects on the likelihood of investment. The direct effect is greater transparency and the indirect effects can be classified into two: effective punishment decreases the costs of building reputation for honest business, and a strong rule of law influences the attitudes of confidence towards markets and contracts.

In this same way, Haggard, MacIntyre, & Tiede (2008) state that the security of property rights drives investment and the integrity of contracts promotes trade, which has a positive effect on economic growth.

Jerbashian & Kochanova (2016) analyze how the institutional framework for doing business enables investments in the information and communication technologies sector, finding that these increase with the strength of legal rights and lower cost of starting and operating a business.

In fact, investment decisions are also affected by those institutions that regulate the activities of the telecommunications sector. Baudrier (2001) analyzes 30 regulators in Africa and Latin America, finding that an independent regulator has a positive impact on the penetration rate of telecommunications services.

The same results are obtained by Machado, Oliveira, & Novaes (2008), who define a methodology to measure the degree of independence of a regulator, which interacts with regulatory processes so that this independence is crucial to attract investment.

Recently, Newman (2019) finds that the type of regulatory regime (in relation to independence) has a statistically significant impact on the number of fixed service lines and prices in the telecommunications sector.

There is, therefore, a diversity of potential factors which may determine the levels of investment in the telecommunications sector. As for Latin America, evidence is particularly scarce, given that there are limited empirical analysis with a solid theoretical background to identify the main drivers of decisions to deploy networks in this region, to the best of our knowledge.

3. A Theoretical Model

In order to analyze the effects of regulation on investment, we will take as a basis the model proposed by Alesina et al (2005). In this model, the level of capital and labor is chosen by the enterprises to maximize the present value of the cash flows that will be received, in the following way:

$$V_i = \sum_{t=0}^{\infty} e^{-rt}\left[F(K_i, L_i) - W_i L_i - CAPEX_i - \frac{b_i}{2}\left(\frac{CAPEX_i}{K_i}\right)^2 K_i^{\sigma}\right] \quad [1]$$

In equation [1] K_i and L_i represent respectively the capital and labor stocks, while W_i is the nominal wage, $CAPEX_i$ is the level of investment, r the real interest rate that we assume exogenous and constant, as a small economy, whereas i and t index respectively country and time-period. It is implicit in the function V_i that firms in the telecommunications sector face adjustment costs denoted by the term $\frac{b_i}{2}\left(\frac{CAPEX_i}{K_i}\right)^2 K_i^{\sigma}$, where b_i is the specific factor of adjustment costs and σ a parameter related to the magnitude of the adjustment on capital.

We will suppose that the production technology is defined by a Cobb-Douglas function with fixed costs, as proposed by Rotemberg and Woodford (1995), with increasing returns to scale of the form:

$$F(K_i, L_i) = AK_i^{\alpha} L_i^{1-\alpha} - \Phi \quad [2]$$

Now, modifying the model of Alesina et al (2006), we will define the effect of regulation on investment:

$$b_i = e^{\psi_i + \gamma REG_i - \rho ICT\_INS_i - \theta INS_i} \quad [3]$$

Where ψ_i represents time-invariant idiosyncratic effects, which may make some countries more prone to attract investments because of unobserved characteristics. In turn, REG_i is a measure of regulatory intensity, which takes lower (higher) values the most flexible (rigid) regulatory environment, ICT_INS_i refers to the quality of specific sector institutions and INS_i that represents the quality of the country's national institutions. Both institutional variables are related to a negative parameter, because larger institutional quality is expected to reduce the costs related to investment.

Investors maximize the present discounted value of cash flow V exposed in equation [1] subject to the capital accumulation equation:

$$\Delta K_i = CAPEX_i - \delta K_i \quad [4]$$

Where δ accounts for the depreciation rate of current capital stocks, which we will assume as constant.

Therefore, by introducing equations [2] and [3] in the cash flow represented in [1], and considering the capital accumulation expression reported in equation [4], the Lagrange function subject to optimization can be expressed as:

$$\mathcal{L}_i = AK_i^{\alpha} L_i^{1-\alpha} - \Phi - WL_i - CAPEX_i - \frac{e^{\psi_i + \gamma REG_i - \rho ICT\_INS_i - \theta INS_i}}{2}\left(\frac{CAPEX_i}{K_i}\right)^2 K_i^{\sigma} + \lambda[CAPEX_i - \delta K_i] \quad [5]$$

Where λ is the shadow value of capital. Deriving the first order condition with respect to investment yields the first order condition with respect to *CAPEX*:

$$\frac{\partial \mathcal{L}_i}{\partial CAPEX_i} = -1 - e^{\psi_i + \gamma REG_i - \rho ICT\_INS_i - \theta INS_i}\left(\frac{CAPEX_i}{K_i^{2-\sigma}}\right) + \lambda = 0 \quad [6]$$

From which, after some algebra, and following Alesina et al (2005) who implicitly work with the assumption of σ=1, we can derive the following equation:

$$CAPEX_i = (\lambda - 1)K_i\, e^{-(\psi_i + \gamma REG_i - \rho ICT_{INS_i} - \theta INS_i)} \quad [7]$$

Where we assume λ>1, as *CAPEX* cannot be negative. Equation [7] represents the investment decisions for the transition of *K* towards its steady state and it will be our target.

4. Data Description

The data panel is composed by 30 countries in Latin America and the Caribbean for the period 2001-2016[2]. Table 1 summarizes the dataset with the respective descriptive statistics. The regulatory intensity will be approximated by five variables that try to capture the regulatory rigidity in the deployment and use of the infrastructure, but also in the sector environment: 1) obligations to monitor the quality of service 2) restrictions in granting licenses, when they are not general authorizations or simple notifications 3) restrictions on band migrations 4) obligations of local loop unbundling and 5) Co-location / site sharing mandated, data obtained from the International Telecommunications Union (ITU) ICT Regulatory Tracker.

In addition, the sector institutional variable will be measured as a dummy variable where 1 represents an institutional setting with an independent regulator, autonomous in decision-making, and with a competition authority, 0 otherwise.

Likewise, the variable that we use to reflect the quality of national institutions is the index of public institutions, used in the Global Competitiveness Index (GCI) of the World Economic Forum. This index of public institutions is composed of 5 indicators that show the perceptions of businessmen about the quality of public institutions in these dimensions: 1) property rights, 2) ethics and corruption, 3) undue influence, 4) performance of the public sector and 5) security.

[2] The countries that were taken are: Argentina, Bahamas, Barbados, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Rep, Ecuador, El Salvador, Grenada, Guyana, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, St. Kitts and Nevis, St. Lucia, Vincent and the Grenadines, Suriname, Trinidad & Tobago, Uruguay, and Venezuela.

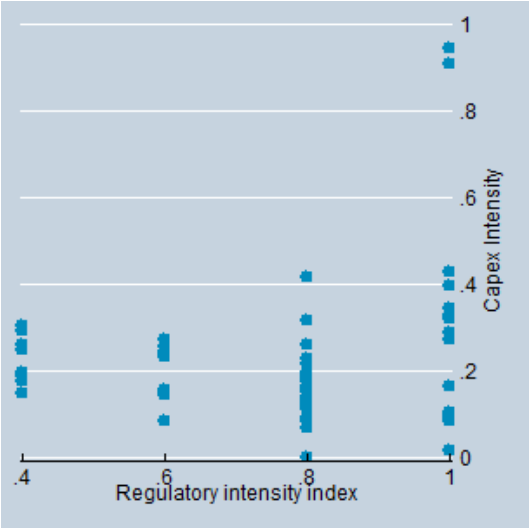
Table 1. Variable description

Variable	Definition	Mean	Std. Dev.	Source
CAPEX Intensity	Annual investment made by entities providing telecommunication networks and/or services for acquiring or upgrading fixed assets less disinvestment owing to disposals of fixed assets as a percentage of annual revenue for telecommunication services. Data expressed in percentage	0,22	0,14	ITU World Telecom / ICT Indicators database
Regulatory intensity index	Indicator for regulatory intensity, 0-1. Builded as the summation of the following indicators for regulatory requirements: (Quality of Service monitoring, Restricted licences, Band migration restriction, Local-loop unbundling, Co-location/site sharing).	0,77	0,18	ITU - ICT Regulatory Tracker
Institutional ICT index	Dummy variable, taking 1 where there is an independent and autonomous regulator and a Competition authority, 0 otherwise	0,70	0,45	ITU - ICT Regulatory Tracker
National Institutional index	Public Institutions indicator (scale 1-7). It is composed by several sub-indicators (equally weighted): • Property rights (Property rights, Intellectual property protection) • Ethics and corruption (Diversion of public funds, Public trust in politicians, Irregular payments and bribes) • Undue influence (Judicial Independence, Favoritism in decisions of government officials) • Public-sector performance (Wastefulness of government spending, Burden of government regulation, Efficiency of legal framework in settling disputes, Efficiency of legal framework in challenging regulations, Transparency of government policymaking) • Security (Business costs of terrorism, Business costs of crime and violence, Organized crime, Reliability of police services)	3,32	0,65	WEF - The Global Competitiveness Index dataset 2007-2017
IHH	Mobile Herfindahl-Hirschman Index	5358.1	2271.2	GSMA Intelligence
GDP	Gross domestic product per capita in USD	7539.2	4398.5	World Bank / World Development Indicators
POP	Population density measure as people per sq. km of land area	119.7	139.8	World Bank / World Development Indicators

***Source**: Author's own elaboration.*

The relationship of our variables of interest compared with the intensity of capital investments is shown below graphically. Figure 1 shows the capital intensities in each one of the possible values of the regulatory intensity index, a very evident relation between the two variables is not observed, in fact it seems to be positive, however, the individual or time effects could hide the true correlation.

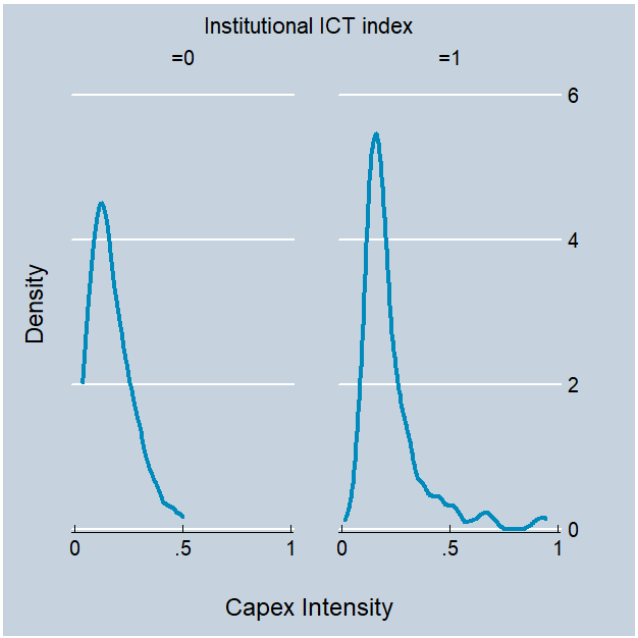
Figure 1. Scatter plot of Capex intensity vs Regulatory index



***Source**: Author's own elaboration.*

On the other hand, Figure 2 shows the kernel of the intensity of investment for two groups of observations regarding sectorial institutions: Weak, where the institutional framework does not count with an independent and autonomous regulator and with a competition authority, represented by "0" (left) and the Strong (right) with these two characteristics, represented by "1". A greater predisposition to invest can be seen with institutional frameworks characterized by independence.

Figure 2. Kernel density of Capex intensity by Institutional ICT index



***Source**: Author's own elaboration.*

Finally, we can see in Figure 3 the positive relationship between the index of quality of institutions at the national level with a greater intensity of Capex.

Figure 3. Scatter plot of Capex intensity vs National Institutional index

***Source**: Author's own elaboration.*

5. Estimation Results

Due to the lack of data regarding capital stock for Latin American countries, we will assume that capital maintains a constant relationship with the sector's revenues in the following way:

$$K = \mu\, REV \qquad [8]$$

Where REV represents the revenues and μ is the factor that related capital with income.

To estimate the model, we take equations [7] and [8], move the variable REV to the left side of the equation and apply logarithms, defining $\Omega_i = \mu + Log(\lambda - 1) - \psi_i$ and we get the final equation to be estimated:

$$\log\left(\frac{CAPEX_{it}}{REV_{it}}\right) = \Omega_i - \gamma REG_{it} + \rho ICT_{INS_{it}} + \theta INS_{it} + \eta X_{it} + \zeta_t + \varepsilon_{it} \qquad [9]$$

Where Ω_i is the country effect that captures time invariant characteristics, ζ_t shows time related effects, capturing economic cycle related shocks, i represents each country and t is a time variable in years.

X_{it} will be our control variables, following Kim, et al (2011), we use the mobile Herfindahl-Hirschman Index to control by level of competition, GDP per capita and population density for taking into account demand and economic environmental elements.

Our parameters of interest are: $-\gamma$, a term which we expect to be negative in line with most of the literature, revealing a restrictive effect of regulation on the capacity of business decisions in terms of investment, ρ, that we expect to be positive reflecting the benefits of having an independent and autonomous regulator and an authority that is responsible for punishing anti-competitive behavior, and, lastly, θ should be equally positive, showing the advantages of having institutional frameworks with strong rule of law, where property rights are respected, security is guaranteed and government is efficient, among other elements.

The first block of columns in Table 2 show the results of the joint estimation between the three indices with the control variables. The first column (i) shows the pooled regression and the next two in its version with random effects.[3] It is observed that in all the estimations the regulatory index has the sign that we expected but it is not significant in any of the specifications, this may be due to the high multicollinearity that may occur between the three indices. For its part, the institutional index of the sector is significant in the pooled estimation and with the expected sign, showing that the existence of an independent regulator and a competition authority correlates with higher levels of investment, but loses significance when introducing random effects. Likewise, the national institutional index is significant in all specifications and shows evidence of a positive relation of the perceptions that entrepreneurs have on the institutional quality and telecommunications investments.

[3] We obtain a p-value of 0.41 in the Hausman test, so we do not find statistical evidence to reject the null hypothesis, that is, the coefficients do not differ statistically from those estimated by fixed effects and the random effect estimation is preferred, which is more efficient given the small sample.

Table 2. OLS Random effects estimates for all indexes

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Regulatory intensity index	-0.1751	-0.3028	-0.3229	-1.2711*		
	(0.385)	(0.547)	(0.481)	(0.666)		
Institutional ICT index	0.4856**	-0.0963	0.2612		0.2066*	
	(0.217)	(0.209)	(0.240)		(0.110)	
National Institutional index	0.4529***	0.3500**	0.4190***			0.2885**
	(0.105)	(0.164)	(0.140)			(0.125)
IHH	-0.0009***	-0.0007**	-0.0006*	-0.0003	-0.0002	-0.0001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
IHH squared	0.0000***	0.0000***	0.0000**	0.0000	0.0000	0.0000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Gdp per capita	0.0000	-0.0000	-0.0000	-0.0000	-0.0000**	-0.0000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Population	-0.0006	-0.0004	-0.0005	-0.0010	-0.0004	-0.0005
	(0.001)	(0.001)	(0.001)	(0.002)	(0.000)	(0.001)
Country Random Effects	No	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Time-effect	No	No	Yes	*Yes*	*Yes*	*Yes*
Observations	60	60	60	72	72	127

***Source**: Author's own elaboration. Notes: *p<10%, **p<5%, ***p<1%. Estimation method OLS. Standard errors in brackets.*

To avoid that multicollinearity affects the estimates of the parameters, the second block of estimates in Table 2 report results for each of the indices after being introduced by one-by-one, to analyze the specific effect of each of the regulatory and institutional elements that are affecting Investment decisions.

Column (iv) reports the estimates for random effects for the regulatory intensity index, with results suggesting a significant and negative effect, with may suggest that stricter regulatory regimes with stronger obligations on operators are related with lower sectoral investments. In the same way, column (v) reports the estimates for the ICT institutional index effect, which was found to be positive and statistically significant at 10% level, so we can infer that maintaining an institutional framework with an independent regulator, which has autonomy in its decisions, and at the same time the country has a competition authority seems to be contribute to generate confidence in private investors. Finally, column (vi) confirms the relevance of the national institutional index, with a positive and significant, evidence that the institutions of a country have a strong relationship with investment decisions on telecommunications infrastructure. However, these results may be affected by potential endogeneity, which can be originated on measurement errors on some of the chosen variables, and on reverse causality in some cases. For that reason, these results should be taken with caution, and further research will have to be conducted in order to asses a precise causal effect.

6. Conclusions and recommendations

The main objective of this document was to analyze how the regulatory and institutional elements are related to the levels of investment in telecommunications infrastructure in the countries of Latin America.

The results show that strict regulatory frameworks with strong obligations on operators seem to be related with lower investment intensity. In addition, the institutional framework of the ICT sector also has a direct link with investment levels. When there is an independent regulator, which has enough autonomy in making decisions and there is a competition authority capable of avoiding and punishing anti-competitive behavior, investments in the region seem to be promoted. Finally, it was found that the institutions of a country are directly and positively associated with investment decisions in the telecommunications sector. However, future research will have to conduct all these estimates while controlling for any endogeneity concerns, in order to make causality inferences.

In summary, the evidence shows the relevance of promoting flexible regulatory schemes where regulation is guided by social and economic policy objectives prioritizing deregulation and self-regulation mechanisms when these are necessary. Likewise, this type of regulations must be accompanied by the guarantee of the independence and autonomy of the regulators together with a strengthening of the ex-post regulation through the competition authorities. Additionally, it is necessary to strengthen national institutions to facilitate private investments in the deployment of infrastructure so that connectivity opportunities reach more people and foster economic growth.

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