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The Effects of Corruption and Innovation on Sustainability: A Firm-Level Analysis

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Abstract: In recent years, analysts' interest in understanding sustainability as a new and exclusive economic paradigm has been matched by the research for tools that might both promote and hinder it. In particular, innovation has been widely regarded for its beneficial effects on sustainability, whereas corruption has been regarded for its negative implications. This study adds to our understanding of these linkages by revealing that, depending on the nature of the sustainability targets, these important drivers can have varying effects. Therefore, using a sample of Italian firms, through SEM analysis, we estimate two latent variables representing innovation and corruption for their relationship with sustainability in two models, covering two sets of indicators (sustainable industrialization and sustainable employment and labour). Whereas both models' results indicate that innovation and sustainability have a substantial positive link, the relationship between corruption and sustainability yields contradictory results. Furthermore, the findings show a negative relationship between innovation and corruption. As a result, the distinction between types of sustainability leads to a different interpretation of how their driving factors operate. This approach suggests the establishment of more tailored sustainability strategies, in line with the diverse consequences that may arise when corruption, innovation, and sustainability are at play.

Keywords: sustainability; sustainable industrialization and production; sustainable employment and labour; innovation; corruption

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1. Introduction

In recent years, we have witnessed a drastic shift in markets and economic agents' behaviours. As is common knowledge, there has been a genuine change in the economic paradigm with implications on production patterns and business dynamics that should result in sustainability. In this vein, scholars and policymakers have directed their efforts in two directions. On the one hand, firms have become the subject of research while also being encouraged through policy tools to develop and implement instruments for achieving sustainable economic growth.

On the other hand, attempts have been made to identify, investigate, and manage the obstacles to the transition to sustainable corporate growth.

As for the first aspect, firms' innovation has been identified as a critical instrument for accomplishing sustainable goals [1,2]. In its most fundamental sense, sustainability-oriented innovation comprises making purposeful changes to an organization's guiding philosophy, which may have implications for the organization's products, processes, or practices. This is performed with the intention of producing and achieving social and environmental value in addition to financial gains.

As for the second aspect, corruption is regarded as the most serious impediment to achieving sustainability goals. Numerous studies have shown that it is exceptionally

flexible in decreasing many facets of sustainability [3]. It has the potential to restrict economic progress [4,5]. As a result, it is a force capable of upsetting the delicate balance between economic expansion, social inclusion, and environmental protection.

Therefore, from an analytical and theoretical perspective, there is a distinction between the positive effects of innovation on sustainability and the negative effects of corruption on sustainability itself [5]. Furthermore, corruption is viewed as a barrier to innovation: by slowing and weakening it, it inhibits its ability to attain its aims, particularly the sustainable goal [6,7].

This work seeks to increase comprehension of the different relationships among innovation, corruption, and sustainability, while attempting to broaden the scope beyond those indicated above. In summary, the purpose of this study is to show that the distinction between positive and negative effects of two key forces on sustainability is not always so obvious, theoretically supporting the following arguments:

(1) The corruption that impedes sustainability has been explored in a variety of circumstances, acting as "sand". However, it is also true that it can act as grease and thus as a stimulus to sustainability [8].
(2) Innovation may not always work as a stimulus for sustainability; rather, it might have a negative impact and hence hinder sustainability.
(3) The link between innovation and corruption is not always one-way. So, while it is not always true that corruption is the driving element influencing innovation, it is conceivable that the opposite may occur.
(4) Because the sign of the relationship is both positive and negative in both directions, each could represent both a stimulus and a barrier.

From a theoretical standpoint, these arguments are explored by reviewing the literature in the field. It aims to give more in-depth knowledge of the connections, demonstrating how they can change based on the circumstances. This approach could enable the identification of sustainability strategies that are both more targeted and more in line with the variety of implications that may emerge when corruption, innovation, and sustainability are at play. In this way, it can better address the selection of tools for policymakers on how to manage and monitor transformation processes aimed at sustainability.

Firms are at the heart of this study. This choice does not align with the central research strand of systemic sustainability, which is defined as the overall transformation of production and consumption in technological, cultural, and institutional dimensions [9].

However, this actually might have come at the expense of a more actor-oriented perspective, capable of focusing on the critical role played by each actor. There is no doubt that firms play a key role in the transition process for achieving sustainable economic growth. Although economic growth and sustainability have long been viewed as contradictory concepts in the business sector, all of the principles of sustainable development have necessitated rapid changes in corporate practices. This includes the features of the products, the well-being of the employees, and the effects of production techniques on the communities in which they operate. Furthermore, it has been examined how firms can intentionally produce positive externalities and engage public agents as well as communities to join shared strategies that take advantage of scale economies and collective support [10].

From a methodological viewpoint, we apply two structural equation models to estimate the relationship between sustainability—considering two sets of indicators—and two latent variables representative of innovation and corruption.

Italian firms provide an intriguing case study. According to the sustainability development report, Italy is placed 15th in Europe in terms of meeting Agenda 2030 sustainability targets [11] but last when just economic sustainability is considered.

The Italian weakness is mainly economic, probably due to stagnant productivity for more than two decades. However, something appears to have changed recently. With the magnitude of environmental problems, social disparities, and global competitiveness challenges to be addressed, there is an increasing need to revitalize businesses. Firms have progressively rediscovered the importance of green policies and, albeit slowly, are

adapting to a new way of conducting business that takes into account the requirements of the environment and future generations.

It is thus worthwhile to investigate the economic sustainability drivers of Italian firms in order to establish whether this sluggish change is advantageous and to identify the hurdles to sustainable growth. Thus, by expanding our knowledge of the relationship between innovation, corruption, and sustainability, we aim to obtain a deeper understanding of what influences the sustainable goals.

The remainder of this paper is structured as follows: Section 2 provides an overview of the conceptual framework, including insights on the effects of innovation and corruption on sustainability, as well as the bidirectional relationship between innovation and corruption; Section 3 describes the sample and the variables; Section 4 is about the model; Section 5 presents the findings; Section 6 is about the discussion and conclusions.

2. The Conceptual Framework

The relevance of innovation in supporting businesses with transition is well-established, as businesses have been continuously challenged over the past decade to find novel solutions to fulfil sustainability goals. Numerous studies demonstrate that this relationship occurs and has a positive impact on sustainability. However, other studies demonstrate that innovation and sustainability might have contradictory objectives in certain contexts. On the one hand, it is shown that corruption mainly acts as "sand" for sustainability purposes. However, there are circumstances where corruption can act as "grease". Corruption and innovation have a similar link, as do corruption and sustainability. As with the relationship between sustainability, it is designed to have a detrimental impact on innovation. Corruption is explored as a barrier to the primary means of accomplishing sustainability objectives, as innovation commonly operates as one. This argument concentrates on a particular aspect of a bigger phenomenon. Thus, it is feasible to analyse innovation that directs corruption, whose effects are both negative and positive. On the other hand, it is possible to consider corruption acting as both a grease and a sand on innovation.

Figure 1 depicts our conceptual framework.

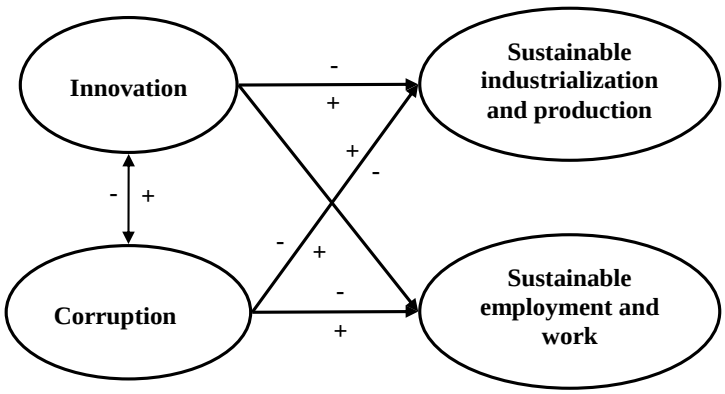

Figure 1. The conceptual framework.

2.1. Innovation

For a long time, markets and society as a whole have been defined by a distorted and progressive interaction between consumption, production, and resource exploitation. The excessive consumption of commodities has necessitated the incorporation of a greater number of natural resources into industrial processes, hence increasing output. This strategy, condemned to fail due to the shortage of resources, has been shown to be reversible [12]. Firms can aim to innovate productive methods and the utilization of more rational resources, which serve as the foundation for similarly rational consumption. These logics demonstrate that the pursuit of innovation is inextricably linked to the pursuit of sustainability. In this context, innovation can be viewed as a revolutionary force that helps organizations to be both competitive and sustainable [13].

Its positive impact on economic growth and development has been extensively studied. In acting as an engine of such virtues processes, many scholars have emphasized how this implies a new industrial revolution, reflecting a radical shift in the structure of the productive processes and the nature of the goods and services, as well as business models, organizational models, and human resource management [14–16].

These drastic changes were feared by firms, since they were deemed beneficial to society but less beneficial to businesses due to their large initial investments and long payback period [17].

However, innovation is not uneconomical when it reflects the introduction of a new cultural paradigm that is applicable to both the firm and society. On this line, it has been proved that alternative means to the conventional ones deemed useless to production not only favour the correct destination of the materials but may also result in a cost reduction and thus competitive performances [18,19]. Both system optimization (e.g., fuel efficiency, low-emission technologies, and encouraging circular economy) and singular innovation, such as the adjustment of production/consumption chain parts, have been found to boost economic performance [20–22].

As a result, many analytical works tend to show both the positive effects of innovation on both sustainability and economic performance [23–25].

Redesigning and inventing new technologies and, most importantly, investing in research and development render the organization visible and credible to stakeholders, especially customers. Therefore, the organization is motivated to engage in an innovation process geared toward sustainability [2]. In addition, the relationship between economic innovation and sustainability is one of the sub-dimensions of innovation with the greatest influence on sustainability followed by environmental innovation and sustainability performance [26].

2.2. The Conflict between Innovation and Sustainability

Sustainability and innovation can have conflicting objectives.

The problem with substantially encouraging innovation activities is that it fails to recognize that innovation is not always sustainable and that the type of innovation matters.

When innovation is directed toward sustainability, it aims to bring about changes that benefit society as a whole. It represents a mediated advantage, not just in terms of economic growth for enterprises but also for the environment and people.

Then, there is a second type of innovation that prioritizes the firm's advantage over the societal good.

The first attempts to fundamentally alter the current production and consumption system by eradicating unsustainable behaviour and gradually abandoning established industries. The second type of innovation is focused solely on optimizing technology and strengthening skills. As a result, it is well matched with existing firms' competencies but not with sustainability [7].

Consider technological advancements that enhance the performance of conventional cars. Simultaneously, some automakers have invested in the development of electric vehicles, which reduce CO_2 emissions but raise battery disposal concerns, and relatively few have invested in compressed air vehicles, which represent the genuine ecological innovation in the automobile industry today. In the first scenario, the relationship with sustainability is non-existent; in the second case, it is relative; and in the third case, it is really substantial. Consequently, there exists an innovation that is not sustainable and whose degree of unsustainability is proportionate to the prominence of the sectors that employ it, with the only purpose of generating new demand for current products and services while maximizing profit [27].

Because the objectives of innovation in the traditional sector (and huge industries) differ from those of innovation aimed at more radical transformation, we are moving along two separate trajectories. The first, a new industrial model concept, leverages innovation

to gradually eliminate old paradigms, whilst the second endeavours to improve these old paradigms by enhancing technology and skills.

It is usual for innovations aiming at affecting a fundamental change in the production model to originate from new operators rather than traditional operators and industries, making a dramatic transition difficult and, above all, slow.

To date, it is extremely difficult to believe that innovation as traditionally employed will be abandoned within a short time frame. It is a matter of generating new markets, sustaining a different demand, and incurring extraordinarily high costs to meet a challenge that, at least in the short term, not all organizations wish to undertake.

Innovation that is primarily motivated by profit does not, by definition, have sustainable goals.

2.3. Corruption as Sand or Grease to Sustainability

Corruption is considered one of the greatest hurdles to economic progress, social development, and poverty reduction, according to the World Bank (2021) [28]. In this vein, the prevalence of corruption-related work tends to accentuate its negative effects: the main focus is on the adverse consequences on institution quality, investment growth, economic growth, social capital, and ultimately sustainability [29]. Even though the phenomenon can manifest in a variety of ways that result in distinct criminal typologies within each nation's criminal justice and administrative systems, it is possible to generalize it. Thus, as public corruption, it can be considered as an illegal offer (almost always monetary) made by a private agent on behalf of an undertaking to a public agent to obtain a public service for the benefit of the undertakings, either unduly or more quickly than others or exclusively, thereby excluding other undertakings [30]. As private corruption, the illicit agreements involve two firms that tends to gain competitive advantages by distorting market rules and eliminating competition [31].

In this sense, it would act as a brake, weakening and impoverishing democratic systems, national security, and economic and social stability [32].

It is consequently typical to compare corruption to "sand" because of its potential to slow down "the wheels". It has been established that, in order to act as a "sand," particular conditions are required, including the existence of complex rules and significant regulatory costs for both national and multinational enterprises trying to enter the market [33].

The promise of a bribe to a public agent, combined with the low level of control and the risk of punishment, is a particularly effective incentive in low-income countries, whereas it would appear to be less effective in high-income countries [34]. This does not mean that corruption does not undermine the industrialized countries where it has been shown to have a strong correlation with budget deficits [35]. The common effect of corruption in all of these conditions is the impediment it represents to economic progress, particularly sustainable economic growth. It is believed that development is useless unless it can be perpetuated regularly [8]. If sustainability is a long-term effect, multiple "positive acts" that operate in concert to achieve a complex objective are necessary. Corruption is capable of interfering with each individual activity, hence preventing the achievement of sustainability goals [36].

Absalyamova et al. [37] demonstrated that a 1% increase in state corruption results in a decline of more than 1% in the Index of Sustainable Development of Human Capital (HCSDI) for that state. Islam et al. [38] describe the connections between rising levels of corruption and environmental deterioration, putting environmental sustainability in jeopardy. It is claimed that corruption impedes the implementation of laws to alleviate environmental deterioration, hence endangering environmental sustainability.

However, there are further data in the literature that support the "greasing the wheels" idea. The data indicate that corruption seems to have a positive effect on the economic and sustainable growth of nations. Jiang and Nie [39], for instance, provide empirical evidence of China's economic boom of continued GDP development despite pervasive government corruption. By performing a comprehensive assessment of Chinese companies

between 1999 and 2007, they found that corruption has a positive effect on company profitability, albeit limited to private firms. Corruption seems to be the remedy for lowering administrative time, the risk of failing to award a contract, and the danger of failing to enter and survive in a market. Consequently, it acts as an illegal method of increasing company performance and profitability. The worse the quality of a country's institutions and government, the greater the capacity for corruption to influence resource allocation.

Paying a bribe to enter a foreign market is an acceptable and favoured practice, even for firms that would never use bribes in domestic markets. Consequently, businesses flourish and expand with an entry pass that would not be possible without it. Corruption can attract international investors because bribes can circumvent restrictions and laws, providing a "helping hand" to overseas investors [40].

As for firms that operate in domestic markets, it has been demonstrated that corruption can counteract government failure and improve economic growth given exogenously determined inadequate bureaucratic norms and regulations [41]. Corruption may drive the most productive firms to circumvent stringent and restrictive regulations and onerous bureaucratic procedures. In such inefficient administrative contexts where corruption functions as an incentive, it has been proposed that corruption can improve quality among public officials [42].

Furthermore, the influence of corruption on the growth of 54 developing countries has been shown using panel data [43]. According to the study, corruption has an important influence in the progress of countries with weak institutions. As a result, corruption can be considered as beneficial to such nations. Given a country's political insecurity, ineffective governance, and poor institutions that stifle growth, corruption, particularly bribery, greases the wheels of growth by generating funds, often known as "speed money". This "fast money" helps to lubricate the economy and boost growth.

This literature only covers economic growth and does not address sustainable economic growth. However, the logic could be seen as valid. If high levels of corruption correspond to (seemingly) paradoxical growth at the macro level, this would imply that corruption represents a collective fee system of time reduction to obtain permits for encouraging investment whose economic objective could, for example, be environmentally sustainable. At the micro level, it is not difficult to uncover examples of corporations that are ambidextrous, that is, they perform corporate social responsibility while also being implicated in corruption incidents [44].

2.4. Innovation–Corruption: A Bidirectional Relation

2.4.1. Does Innovation Control Corruption?

Few studies examine the relationship between innovation and corruption, and even fewer investigate the idea that innovation can exert control over and reduce corruption. However, from a theoretical standpoint, the potential of innovation as a barrier to corruption appears to be extremely clear. The principal–agent theory was used in the articles that investigated the effect of innovation in influencing the level of corruption. The role of principal is held by elected officials, many of whom have insufficient knowledge of operational activity. The officials employ managers as their agents who typically possess the information essential to supervise an entire economic activity. This allows agents to determine the trend of a specific sector by increasing possible monopolies or creating barriers to entry, both of which can be the result of corrupted relationships. Firms gain from privileged positions achieved through the corruption of officials who are not politically controllable but are placed in a position to influence the firm's success or survival [45]. The innovation would be the instrument capable of changing the agent–customer relationship, for two reasons. The continual changes brought about by innovation tend to limit the agent's expertise when determining the sector's trend. Consider the awarding of a contract due to a bribe where innovation is a key means in the development of activities. Due to the official's lack of understanding regarding the required competence for the expansion of an activity, the concession would be simple to appeal from competing enterprises. The second

aspect is that innovation would have to divert firms' attention away from discovering easier ways to achieve a result. They may opt to focus on innovation to gain a monopoly or boost profit by gaining a competitive advantage. This can be accomplished by raising the level of innovation. Individuals and firms have little or no incentive to give bribes when the level of innovation is high: resources are utilized efficiently in manufacturing processes that are adequate to meet competitiveness targets without the need for unlawful action. To our knowledge, the only work that provides empirical evidence for this idea is by Bosco [46]: the author demonstrates how investing resources in technological advancement raises relative yield on production and can result in an endogenous drop in rent-seeking activities.

2.4.2. Does Innovation Promote Corruption?

This aspect of innovation is also little explored. The research in this area focuses on the fact that innovation creates processes, techniques, information flows, and items that, in addition to attaining legitimate goals, can also be used to achieve illegal goals, first to promote corruptive behaviours.

The primary reason is that what is new is poorly known and hence might be used to ensure interactions that are seen as opaque, as they are hidden. Digitization is the most prominent example of an innovation advancement that could be beneficial to corruption in this regard. Digitization provides access to an integrated big-data network with potential benefits for society and the environment. The development of Internet-connected intelligent systems can provide unprecedented potential for proactively addressing the challenges associated with the Sustainable Development Goals and ensuring a just, environmentally sustainable, and healthy society. At the same time, technological innovation such as the block chain has enabled applications for the digitalization of business processes, products, and services, which might result in more chances for the implementation of corrupt business practices due to the opaque nature of these applications [47]. Adoption of innovative digitized technologies, such as the usage of AI-enabled HR software, has been identified as an issue that may lead to corrupt corporate practices, owing to the lack of awareness and insufficient knowledge among users of such programs [48]. Consequently, there is a negative component to digitization, notably in the use of platforms by small firms, which coexists with its various good effects.

The mass production of commercialized electronic devices presents an additional innovation-related challenge. It is self-evident that the greater the investment in innovation, the greater the pressure for economies of scale in manufacturing. The issue it causes is an increase in the number of electronic devices on the market, as well as an increase in industrial electronic waste. Due to high prices and a lack of sufficient infrastructure that can improve recycling operations and hence reduce costs, they can be recycled inefficiently [49]. Companies have frequently utilized the high disposal costs as encouragement to enter into unethical arrangements with low-income countries in order to purchase this type of waste. In fact, Nigeria, Ghana, and numerous Gulf of Guinea nations have become the world's illegal dumping grounds for electronic waste, especially industrial waste. Many tonnes of e-waste, including cables, screens, obsolete phones, and electrical devices of all types, go to Africa as they reach the end of their useful life if they are not disposed of or recycled appropriately at the source [50].

2.4.3. Corruption as Sand or Grease to Innovation

Scholars have yet to discuss how corruption influences innovation by addressing both the positive and negative consequences concurrently, while traditional literature explicitly ties the issue of innovation and corruption solely using a linear approach.

In reality, from a theoretical standpoint, the fact that corruption both stifles and fosters innovation is not a contradiction in terms. However, two conditions must be met in order for this to be achievable. The first is a common scenario in which the authority that distributes patents is slow, the procedures for obtaining patents are exceedingly complicated, and the

patent charges are expensive. That is, there is an impediment shared by all firms for the patent to be granted in a timely and fast manner in relation to the company's research and development operations. There is a risk that time wastage combined with the complexity of bureaucratic systems would slow down the process, hence diminishing the proposed innovation's added value. The second prerequisite is the presence of firms whose positive or negative effects are tied to their characteristics. Typically, the relationship between corruption and innovation is asymmetric [51].

Companies profit from corruption because they can pay or have a fiduciary relationship with a public agent. As a result, businesses reap the benefits of decreased time, the assurance of obtaining a patent that attests to the existence of an implementable innovation, and a succession of priorities from the time of application to the time of acquisition. Other businesses are stymied by this approach because they cannot afford to pay or do not pursue corruptive relationships to obtain patents. Corruption acts as a lubricant for the former and as sand for the latter.

According to Paunov [52], the different effects that corruption has on corporate innovation are determined by the enterprise dimension. Therefore, corruption has a more detrimental effect on the innovative capabilities of smaller businesses than it does on those of larger businesses. Smaller firms typically have lesser revenues and more costly financing limits. They cannot benefit from corruption because they are often less financially available. Furthermore, because corruption is unlawful, corrupt authorities prefer to bargain with larger corporations that can engage in a long-term partnership. In other words, officials want to form exclusive and long-term trust relationships in order to reduce the risk of complaints and the spread of corrupt trades. Similarly, corporations in low-income countries have a less distinct impact exactly because the number of enterprises that cannot afford a bribe grows, forcing them to use more inefficient but less expensive technologies.

Another distinction that aids understanding of the various effects of corruption on innovation is the distinction between patents and quality certificates.

Paunov likewise finds a significant detrimental impact, particularly when quality certificates are increased at the expense of patents. This is due to the fact that the evaluation rules for some quality certificates are less apparent, whereas patents are granted based on more objective criteria. Furthermore, corrupt authorities have a poor negotiating position when it comes to patents because corporations can apply for international patents outside of the country to escape corruption. Quality certificates are then a source of money that must be revalidated, but a patent cannot be cancelled once issued. In summary, corruption has a positive impact in some circumstances. It concerns firms who regularly undertake or seek to invest in innovation in countries with delayed administration and low levels of monitoring, and for these it becomes a tool to eliminate any source of doubt associated to the acquisition process of patents or quality certificates.

Therefore, relationship corruption can serve as an aid to long-term planning and a method for reducing uncertainty. In hostile governance systems, it is essential to reduce not just the risk of not obtaining the concession but also the risk of losing income earned by the investment in research.

Corruption, on the other hand, acts as sand for all other firms under a system where those who corrupt to secure a patent have priority, because it raises the danger of a non-returning investment. As was previously said, it becomes less practical to invest in innovation, and it is preferable to return to conventional industries where the risk of revenue loss has been mitigated over time.

3. Sample and Variables

We have collected a database of 1666 observations regarding Italian firms found guilty of corruption with a third tier and final verdict, complemented with regionally based innovation and sustainability features (see below). The study used systematic random sampling to gather the sample of corrupt firms, which covered around 30% of the target population of sentences carried down by the Supreme Court from 2013 to 2019 [53].

We focused on corruption crimes committed by individuals acting on behalf of Italian companies. Companies in Italy are not prosecuted criminally but are held accountable under administrative law [54]. The decision to focus on crimes stems from the fact that they represent the most serious violation contemplated by the Italian system, and as directly committed by agents, they more accurately capture the characteristics of corruptive dynamics on both the demand and supply sides.

3.1. Variables

3.1.1. Indicators of the Latent Dependent Variable Sustainable Industrialization and Production

The latent dependent variable was utilized in model 1; it includes sustainable development objectives 9 and 12 as defined in Agenda 2030 since, according to their respective sub-objectives, both are associated with firm strategies and, more specifically, production decisions.

As indicators, we thus use the proxies described for a number of sub-objectives by ISTAT, developed at the regional level [55]. As a result, data have been drawn on the ISTAT website. Specifically, we consider: (1) the manufacturing value added as a proportion of GDP per capita (sub-objective 9.2.1), (2) the proportion of small-scale industries in total industry value added (sub-objective 9.2.2), (3) the proportion of small-scale industries with a loan or line of credit (sub-objective 9.3.2), (4) the carbon emissions in terms of tons of equivalent CO_2 emissions (sub-objective 9.4.4), (5) the national industrial recycling rate in terms of tons of material recycled (sub-objective 12.5.1), (6) the number of companies publishing sustainability reports (sub-objective 12.6.1), and (7) the number of firms' sustainable tourism strategies and implemented action plans with agreed monitoring and evaluation tools (sub-objective 12.6.1).

3.1.2. Indicators of the Latent Dependent Variable Sustainable Employment and Work

In model 2, the latent dependent variable includes sustainable development objective 8 as outlined in Agenda 2030, as it has a direct relationship with firms about the level of growth and the number, diversity, and nature of sustainable labour. Thus, as in this case, we take as indicators the regional proxies indicated by ISTAT as its sub-objectives [56], from which, once again, we derived the data. Specifically, we consider the following key-indicators: (1) The annual growth rate of real GDP per capita (sub-objective 8.3.1), (2) the proportion of youth (aged 15–24years) unemployment rate, by sex, age, and persons with disabilities (sub-objective 8.5.1), (3) the proportion of youth (aged 15–24 years) not in education, employment, or training (sub-objective 8.5.2), (4) the proportion of informal employment in non-agriculture employment (sub-objective 8.6.1), and (5) the frequency rates of fatal and non-fatal occupational injuries, by sex and migrant status (sub-objective 8.8.1).

In many studies, both kinds of indicators are used as proxy measurements to assess sustainable development goals at the firm level [16,56,57]. The explanatory latent variables are for both the innovation model and the corruption model.

As for innovation indicators, we used the primary proxies connected to four sub-objectives of objective 9 as outlined in Agenda 2030, which were specifically centred on innovation tools. Thus, we consider: (1) the research and development expenditure as a proportion of GDP (sub-objective 9.5.1), (2) researchers (in full-time equivalent) per million inhabitants (sub-objective 9.5.2), (3) the proportion of medium and high-tech industry value added in total value added (sub-objective 9.b.1), and (4) the proportion of territory covered by a mobile network, by technology (sub-objective 9.c.1). These indicators were also established at the regional level.

They have frequently been employed as proxy measurements in studies examining the extent of company sustainability innovation [58–60]. Corruption indicators were gathered from the 2013–2019 archives of the Italian Court of Cassation (http://www.italgiure.giustizia.it/sncass/ (accessed on 12 December 2022)) and comprised around

1666 observations from randomly selected verdicts on firms' corruption. As the highest criminal court in the legal system, the Court of Cassation's verdicts are final and non-appealable. As a result, they provide judicial certainty, allowing thorough information concerning corruption to be obtained. We divided the samples into two groups based on whether the crime of corruption involves events linked to industrialization and production models (around 1460 judgments) (model 1) or employment or work-related events (around 200 judgments) (model 2).

Thus, we consider the following indicators for each sample: (1) The intensity of corruption: this refers to the quantity of illegal money obtained as a result of corruption. A monetary measure of corruption gives a compelling explanation for the extent of corrupt practices [32]. (2) The duration of the corruption in months. The longer it lasts, the more serious it is likely to be [61]. (3) Involvement in corruption. Thus, in increasing order of seriousness, we define: (i) individual crime, (ii) basic criminal association in circumstances where persons commit only one crime together, and (iii) organized crime, which is distinguished by continual criminal collaboration and an organizational framework [62,63]. (4) the custodial sentences expressed in years. (5) The presence of aggravating circumstances: the presence, expressed in number, of conditions that heighten the severity or culpability of a criminal act [64].

4. The Model

In this work, the relations between sustainability, innovation, and corruption are evaluated through structural equation model analysis (SEM analysis). Sustainability, innovation, and corruption are viewed as latent concepts measured by a set of indicators in various works [65,66]. Therefore, the relationship between these variables must be evaluated using appropriate empirical models, such as SEM.

Structural equation modelling is a useful technique for assessing a theoretical model that hypothesizes how sets of variables form constructs (latent variables) and how these constructs are related to one another [67].

Formally, SEM analysis consists of two parts: the measurement model and the structural equation model [68].

On the hypothesis that the latent variable determines its observable indicators, the measurement model relates the latent variable to its multiple observable indicators. Measuring the latent variable is advantageous since it provides more information than the individual indicators. Formally, the measurement model is described as follows:

$$y' = \Lambda\eta + \varepsilon \quad (1)$$

where y' is the vector of p indicators for sustainability, innovation, and corruption. Λ is a matrix of regression coefficients, and ε is a vector of white noise with dimensions $(p \times 1)$.

The structural equation model can be evaluated if the relationships between the latent variables and their indicators are validated using the measurement model. The estimation of the parameters is accomplished by comparing the actual covariance matrix, describing the relationships between indicators, to the estimated covariance matrix of the model that best fits the data. Formally:

$$\eta = B\eta + \Gamma\xi + \zeta, \quad (2)$$

where η is a vector of latent endogenous variables, and B is the matrix of coefficients describing the effect of the endogenous latent variables on each other. Each endogenous variable is determined by a set of exogenous causes. Γ is the matrix of coefficients describing the effect of each exogenous variable ξ on the endogenous variables η. ζ is the vector of disturbances, assumed to have an expected value equal to zero.

In this work, Γ describes the effects of two exogenous (explanatory) variables, i.e., corruption and innovation, on the endogenous latent variable sustainability. Specifically, we define two models. In the first model, sustainability is measured using sustainable industrialization and productivity-related indicators and considering a sample of 1460

instances of corruption. In the second model, sustainability is measured using sustainable employment and work-related indicators and considering 206 labour-related corruption cases as a sample.

5. Findings

Table 1 shows the results of the SEM analysis and the fit statistics of the model. The chi-squared statistics (p-value < 0.001) indicate a good fit for the model. In addition, the goodness of fit (GFI) and the adjusted goodness of fit index (AGFI) are above the suggested value for both model 1 and model 2. At last, the root-mean-square error of approximation is in the range 0.05–0.08. Considered overall, the fit statistics reported in Table 1 conclude that the models are suitable with regards to our data [69].

Table 1. SEM analysis results and diagnostic test.

	Model 1		**Model 2**	
Measurement Model	**Estimate**	**St. Error**	**Estimate**	**St. Error**
	Sustainability			
S.9.2.1	0.942 *	0.050		
S.9.3.1	0.792 *	0.061		
S.9.3.2	0.604 *	0.062		
S.9.4.4	0.621	0.054		
S.12.5.1	0.623 *	0.035		
S.12.6.1	0.784 *	0.032		
S.12.b.1	0.712 *	0.074		
S.8.1.1			0.553 *	0.019
S.8.5.1			0.805 *	0.076
S.8.5.2			0.812 *	0.066
S.8.6.1			0.823 *	0.056
S.8.8.1			0.517 *	0.070
	Innovation			
I.9.5.1	0.874 *	0.061	0.853 *	0.011
I.9.5.2	0.590 *	0.044	0.572 *	0.024
I.9.b.1	0.890 *	0.039	0.806 *	0.059
I.9.c.1	0.880 *	0.021	0.872 *	0.061
	Corruption			
Intensity	0.888 *	0.089	0.888 *	0.069
Duration	0.890 *	0.070	0.890 *	0.070
Involvement in crime	0.698 *	0.073	0.697 *	0.083
Custodial sentences	0.905 *	0.070	0.904 *	0.060
Aggravating circumstances	0.711 *	0.053	0.711 *	0.093
Regression	Estimate	St. error	Estimate	St. error
Sustainability~Innovation	0.894 *	0.071	0.641 *	0.061
Sustainability~Corruption	0.287 *	0.035	−0.140 *	0.047
Covariances	Estimate	St. error	Estimate	St. error
Innovation~Corruption	−0.101 *	0.026	−0.788 *	0.086
N. observations	1460		206	
Chi-squared	5380.539 (p < 0.001)		3333.576 (p < 0.001)	
gfi	0.861		0.848	
agfi	0.804		0.802	
rmsea	0.073		0.074	

* p-value < 0.001.

The results show a positive significant relation between innovation and sustainability for both models (0.942, $p < 0.001$ and 0.641, $p < 0.001$, respectively, for model 1 and model 2). Thus, when innovation increases sustainability increases too.

Depending on the two models, the relationship between corruption and innovation yields contradictory outcomes. Specifically, when sustainability is measured by sustainable industrialization and production-related indicators, corruption is positively related to sustainability (0.287, $p < 0.001$). On the contrary, when sustainability is measured by sustainable employment and work-related indicators, corruption is negatively related to the sustainability (−0.140, $p < 0.001$).

At last, the results show a negative covariance between innovation and corruption (-0.101, $p < 0.001$ and 7.88, $p < 0.001$, respectively, for model 1 and model 2). This means that high values of corruption are related to a low level of innovation and vice versa.

6. Discussion and Conclusions

This study attempts to gain a better understanding of what drives firms' sustainable objectives. This goal is being pursued in two ways. The first is theoretical and consists of a brief literature review highlighting the diverse effects of innovation and corruption on sustainability, as well as the reciprocal effects of innovation and corruption.

The second is empirical. Accordingly, the main conclusion drawn from the findings is that relationships differ depending on whether sustainability is associated with industrialization and production processes or with employment and labour processes. When measured by sustainable industrialization and production-related indicators in model 1, innovation is positively related to sustainability. The outcome is consistent with most of the literature, in which investment in research and development through increased production models, such as hi-tech and cutting-edge infrastructures, which are often not only sustainable but also resilient, appears to result in a real competitive advantage for businesses [18,19]. For example, as investment in innovation increases, strategies to meet carbon constraints and consequently reduce emissions can be implemented more efficiently [21].

Corruption has a favourable link with sustainability, as evaluated by sustainable industrialization and production-related indicators. Corruption, in other words, serves as a "grease" on this particular sort of sustainability. The outcome is not surprising given that the model of sustainability interacts with the public administration more frequently in terms of concessions and controls. At the same time, it demonstrates how the Italian public framework is viewed as lacking in governance, which may be circumvented by paying an additional fee to enhance corporate productivity [43,44].

In the case of model 2, sustainability as assessed by employment and work-related variables shows a positive link with innovation but a negative relationship with corruption. The same remarks apply to innovation as to the model 1. Innovation increases the amount of work by generating new positions and expanding existing ones, while also improving the quality of working conditions. As a result, it is an evident benefit for businesses [14,15]. Corruption, on the other hand, diminishes these specific levels of sustainability by functioning as "sand" in this scenario. In essence, distorting market regulations and granting privileged positions to a few enterprises decreases the opportunity for many to invest in employment and enhance working conditions within their organizations. Furthermore, distorting public resources to benefit a few corporations raises expenses for the majority of individuals who do not engage in corruptive actions while being hampered and burdened by complex and opaque bureaucratic processes [32,33]. In these circumstances, employers are typically obliged to lay off rather than hire, and they are unconcerned about improving working conditions.

Finally, the two-way relationship between innovation and corruption is, according to our results, a negative one. According to the preponderance of literature, the result is that corruption hampers innovation. Thus, it serves as sand because, in the environment in which it thrives, it creates preferred methods of obtaining patents, to the detriment of others who do not engage in deceptive practices to achieve recognition [52].

The other side of the coin, though, is that increased innovation lessens corruption. This result shows the significance of innovation as a strategy to maximize profits. In this fashion, the instrument of corruption would become obsolete.

Taken together, our results show that contextualization is required when innovation, corruption, and sustainability are at play. The existence of unique relationships cannot be taken for granted. On the contrary, it is necessary to understand their effects in light of the circumstances. It also seems important to differentiate by sustainability objectives.

Despite the fact that sustainability is usually understood to be a complex phenomenon comprised of a number of extremely interdependent components, it is clear that its separate

dimensions are influenced by the innovation of corruption in a different way. Our decision to emphasize two aggregate dimensions (the latent variables), separated by sustainability objectives, allowed us to examine the nature of the relationships with regard to their variability.

This result has implications for policymakers in particular. Programs and anti-corruption measures can be more effectively targeted with a better understanding of the major factors influencing sustainability targets.

At the same time, the aggregate-level analysis has its own limitations: each item within the two types of sustainability may require a separate examination to better understand how corruption and innovation affect them individually. As a result, one can be able to make more accurate and policy-focused recommendations. An analysis that breaks down individual indicators could represent a significant advancement in this work. A further step forward that we suggest with respect to this work concerns the validation of this model in various scenarios. It would be interesting to check these findings outside national borders due to the fact that this study stresses the significance of context for the functioning of effect relationships.

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