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The Impact of Intangible Assets and Sub-Components of Intangible Assets on Sustainable Growth and Firm Value: Evidence from Turkish Listed Firms

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Abstract: This study explores the effect of intangible assets and sub-components of intangible assets on sustainable growth and firm value in Turkey. The cumulative (i.e., aggregative) value of intangible assets of firms and sub-components of intangible assets were used as test variables in the current study. Further, intangible assets of the firms were divided into three sub-components using the classification of Corrado, Hulten and Sichel, namely computerized information and database, innovative property, and economic competence. Firms listed on Borsa İstanbul were analyzed to test the hypotheses. Two different measures of sustainable growth of firms and unique measure of firm value were used as dependent variables. The final sample includes 1353 observations for nine years between 2005–2013 in Turkey. Ordinary least square (OLS) and Heckman two-stage estimation procedures were employed to test the hypotheses. Estimation results of OLS and Heckman two-stage procedures show that the cumulative value of intangible assets affect the sustainable growth rates of firms and firm value positively. When the cumulative value of intangible assets was classified into three sub-components, both computerized information and database and economic competence impact the sustainable growth rates of firms and firm value.

Keywords: intangible assets; sustainable growth; firm value; computerized information and database; economic competence; innovative property; Turkey; Borsa Istanbul

1. Introduction

In the literature, there are many definitions of intangibles assets. While some of these definitions made by authors refer to one type of specific item among intangible assets (such as brand, trademark, etc.), other authors discuss definitions in a broader context. According to Mooney [1], Siegel and Shim [2], and Andrews and De Serres [3], who discussed intangible assets in a broader context, intangible assets have no physical substance and represent a right granted by the government or by another company. Furthermore, according to Augier and Teece [4], intangible assets are non-current assets and are different from tangible (physical) assets. These differences are that intangible assets are used by one party, their transfer costs are hard to calibrate, their property rights are limited, and the enforcement of property rights is relatively difficult.

There are many types of intangible assets such as patents, copyright, trademarks, design, mineral exploration, brand, software, formula, trade secrets, capitalized research and development, goodwill, databases, domain, human capital, motion pictures, consumer lists, customer loyalty, licenses, market share, and marketing rights [3,5–7]. Even though different countries have enforced local regulations about how to record intangible assets, the International Accounting Standards Board (IASB) determined

some criteria to account, record, report, and value intangible assets at the international level. Thus, many countries have adopted the standards of the IASB into local regulations or use a two-book system to prepare their financial statements in accordance with the standards of IASB and their local regulations, as in Turkey. According to International Accounting Standard 38 [7], intangible assets should be identifiable, should be controlled by the firm, and should provide future economic benefits to the firm, and the cost of intangible assets can be measured reliably if firms report these kinds of items as an asset. In Turkey, firms listed on Borsa İstanbul should prepare their financial statements in accordance with the directions of the IASB. Thus, intangible investments made by firms are included in the financial statements of firms as an asset, if firms abide by the IASB's reporting criteria.

There are many studies that explore the effects of intangible assets or the sub-components of intangible assets or some types of specific intangible assets (such as patent, trademark, R&D) on firm performance [8–12], on firm value [13], on firm level and country level productivity [14–16], on stock price [17–19], on economic growth [3,20,21], on analyst coverage, and analyst following [22,23]. Most recently, some scholars have focused on the relationship between firm governance structures and intangible assets and the sub-components of intangible assets (particularly R&D) [12,24–27].

The outcomes of this research show that firms now invest more in intangible assets than in tangible assets because intangible assets play an effective role in sustaining a firm's competitive advantage [9] due to not being easy to imitate [27] and being an important determinant of firm internalization [10]. Intangible assets such as software and R&D are critical investments that sustain a firm's market presence in future years by reducing costs and increasing profits, and intangibles are strategic investments for the long-run growth path of firms [21]. The sustainable growth of a firm can be considered a comprehensive mechanism to evaluate the long-run sustainability of a firm [28]. On the other hand, investing in intangible assets is important for the knowledge economy because intangible assets containing information elements such as R&D, patents, or software rather than tangible assets play an important role in the sustainable growth of firms and firm value. In this regard, intangible assets of firms may affect the sustainable growth of firms and it will be interesting to discuss the association between the intangible assets and sub-components of intangible assets classified by Corrado et al. [29–32] and the sustainable growth rate of firms. Recently, from the narrow perspective of intangible assets, Xu and Wang [33] researched the effect of intellectual capital which is a common form of intangible investment on firms' sustainable growth rate and found that intellectual capital has a positive impact on the sustainable growth of firms in Korea. We take into account the intangible value of a firm in broader context, covering the aggregative value of intangible assets of firms and the sub-components of intangible assets classified by Corrado et al. [29–32]. The first research question is, do these kinds of strategic investments, intangible assets, make firms benefit from sustainable growth? Which kind of sub-components of intangible assets make firms more likely to have sustainable growth? Intangible assets affect firm value positively [13], because much research has empirically documented the positive effect of intangible assets on firm value. However, which kinds of sub-component of intangible assets are more effective to enhance firm value is still unknown. This issue has not been discussed using the classification of Corrado et al. [29–32] regarding intangible assets.

In this study, we used the cumulative value of intangible assets of firms and the sub-components of intangible assets classified by Corrado et al. [29–32] as variables of interest. In this most commonly used classification, the researchers attempt to categorize three main sources of intangible assets [16,29–32]. These are "Computerized Information and Databases," "Innovative Property," and "Economic Competence." While "innovative property" strongly emphasizes the creation of new ideas and includes items such as patents, rights, films, licenses, and R&D, "economic competence" emphasizes the economic impact of intangibles such as agreements and special costs. "Computerized information and databases" includes software and databases [26]. We employed two measures of sustainable growth of firms and unique measure of firm value as dependent variables. Our estimation model also includes firm structure–specific (firm size, firm leverage, firm performance, firm age) and firm governance–specific (board independency, board gender diversity, top management gender diversity,

CEO duality) control variables. Two different econometric approaches are used to estimate the results. One is ordinary least square, the other is the Heckman two-stage estimation procedure. The Heckman selection model was employed because female participation in the top management level of firms affects firms' intangibles [26,27] and thus indirectly affects sustainable growth of firms and firm value. The results of the two estimation procedures document that intangible assets of firms affect firm value and sustainable growth of firms positively. In addition, two sub-components of intangible assets, namely, "computerized information and database" and "economic competence," positively affect firm value and the sustainable growth of firm.

The paper contributes to the existing literature as follows. First, we provide evidence of the relationship between intangible assets, sustainable growth and firm value of firms listed on Borsa İstanbul for the first time. Second, it determines which kind of sub-components of intangible assets affect the sustainable growth rate of firms and firm value. Third, we used Turkish listed firms and thus, the outcomes of this paper shed light on the effect of intangible assets on the sustainable growth of firms and firm value in emerging markets. The literature on the effect of intangible capital on firm value in Turkey focuses more on a single component of intangible capital, intellectual capital and found a positive relationship between intellectual capital and firm value & performance [34–38]. In this paper, we used various sub-components of intangible capital and its effect both on sustainable growth and firm value.

The following subheadings present literature review and hypotheses regarding relationship among intangible assets and sub-components of intangible assets with sustainable growth and firm value. Then, the research design (sample selection, estimation model) is presented. Finally, the results of this paper are explained.

2. Literature Review and Hypothesis Development

2.1. Intangible Assets and Sustainable Growth

The term sustainable growth emerged in the 1970s in the field of business. Higgins [39] used the term to address firms' optimal growth from a financial perspective. Accordingly, it indicates a maximum rate that a firm grows at relying on its own resources without using any financial tools outside the company.

As far as the relationship between intangible investment and sustainable growth is considered, firms in general make a large amount of physical investment, which is the main source of production. However, they have difficulty with generating non-physical capital including intellectual capital, R&D activities, and innovative activities, and some studies found that the ownership of a large amount of physical capital accelerates the sustainable growth rate of firms [40]. Another stream of literature, on the other hand, presents contrasting results [33,41–46]. Accordingly, intangible investment in various forms positively affects a firm's sustainable growth. A common form of intangible investment is intellectual capital, which is defined as a set of resources including knowledge, capabilities, networks, operation processes, individual, and organizational relations. Xu and Wang [33] found that intellectual capital has a positive effect on financial performance of Korean manufacturing companies. Furthermore, a similar analysis is also tested for another industry. Xu and Wang [41] concluded that intellectual capital contributes to financial performance in the textile industry. In a similar vein, Mukherjee and Şen [42] revealed that intellectual capital is an influencing factor for corporate sustainable growth as much as other factors, including physical capital, relational capital, innovation capital, and process capital. Moreover, Ying et al. [43] argued that intellectual capital affects sustainable growth of firms indirectly. First, it enhances managers' capabilities to discover strategic resources for the firm, which in turn results in performance improvement. Liang et al. [44] emphasized the role of organizational capabilities such as developing new products and changing organizational structure to experience the performance-enhancing effect of information technology. Some authors use R&D expenditure to proxy intangible assets and found that R&D activities positively

affect firm growth [45,46]. Xu and Wang [33] found that advertising stimulates R&D activities through increasing the reputation of the firms' current products and services. Based on these previous studies, we hypothesize that

- H1: Firms with greater intangible assets tend to have better sustainable growth rate;
- H1A: Firms with greater innovative property tend to have better sustainable growth rate;
- H1B: Firms with greater computerized information and databases tend to have better sustainable growth rate;
- H1C: Firms with greater economic competency tend to have better sustainable growth rate.

We expect that the cumulative value of intangible assets and the sub-components of intangible assets (innovative property, computerized information and database, economic competency) have a positive and significant effect on the sustainable growth of firms if the hypotheses (H1, H1A, H1B, H1C) are supported.

2.2. Intangible Assets and Firm Value

There is an extant literature on the relationship between intangible assets and firm value, which is commonly measured as Tobin's Q (see Table 1). Some of these studies focus on specific industries such as semiconductors [37,47,48], communications [49], food [50], and pharmaceuticals and chemicals [51].

Megna and Klock [13], one of the first studies analyzing the effect of intangible capital on firm value, used patents and R&D to proxy intangible capital stock of the firms in the semiconductor industry for the period 1972–1990 and found that intangible capital is an important determinant of firm value. When firm-specific effects are taken into account, Tobin's q varies from one firm to another in the same industry even after adjusting for intangible capital. In other words, the effect of intangibles on firm value is not sufficient to explain the variation between firms. Shane and Klock [47] used patent citations as an alternative indicator for intangible capital and detected a contrasting result to the previous evidence. Accordingly, patent citations do not have a significant effect on Tobin's Q. Chin et al. [48], on the contrary, tested a similar hypothesis and the analysis revealed a positive and significant effect of patent citations on firms, which are valuable players within the value chain in the semiconductor industry. As far as the communications industry is concerned, Klock and Megna [49] used four types of intangible capital, namely R&D, radio spectrum licenses, advertising, and customer base, and found that licenses and advertising contribute to the variation in this industry, but the effect of licenses on Tobin's Q is larger than that of advertising. Wu and Bjornson [50] analyzed the effect of advertising activity and found that advertising activity positively affects the firm value regardless of the changing economic and social conditions in the food industry. In the chemicals and pharmaceutical industry, Gleason and Klock [51] found a similar pattern between intangible capital, which was proxied by R&D and advertising activity, and firm value. We observe further evidences examining the effect of intangible assets on firm value in manufacturing sectors [52–55], technology sectors [36,56], and telecommunications [49]. Tseng and James [52] used four types of intangible capital such as human capital, relationship capital, innovation capital, and organizational capital to construct intellectual capital and found that there is a positive relationship between intellectual capital and firm value, which is measured as Tobin's Q, market/book value, and value added intellectual coefficient. Moreover, Salman et al. [53] revealed that the effect of these subcomponents varies. For instance, the effect of human capital on firm value is larger than that of other types of capital. Ehie and Olibe [54] through using another type of intangible capital, found that R&D investment in the manufacturing sector generates a larger positive effect on firm value than in the services sector. Dženopoljac et al. [55], with a specific emphasis on technology sector, found that there are no differences among ICT sectors in terms of financial performance. Among other components of intangible capital, human capital has the highest impact on firm performance for firms operating in ICT sector [36].

Table 1. Main articles on the relationship between intangible assets and firm value.

Author	Publication Year	Title	Data	Methodology	Results
Megna and Klock [13]	1993	The impact of intangible capital on Tobin's q in the semiconductor industry	11 firms operating in semiconductor industry for the years between 1972–1990	Nonlinear least square estimates	Intangible capital explains the variation in Tobin's q to a certain extent. However, there are other factors playing important role in the substantial differences in q within semiconductor industry.
Klock et al. [56]	1996	Tobin's q, intangible capital, and financial policy	100 large manufacturing firms for the years between 1977–1983	OLS	The inclusion of intangible capital strengthens the financial performance of firms.
Wu and Bjornson [50]	1996	Value of advertising by food manufacturers as investment in intangible capital	Compustat PC plus database for large firms in US capital markets	Cross sectional time series regression	Food manufacturing firms' advertising activity is strongly related to intangible capital value.
Haneda and Odagiri [57]	1997	Appropriation of returns from technological assets and the values of patents and R&D in Japanese high-tech firms	40 firms in electrical equipment industry, 41 firms in chemical industry, and 24 firms in drugs industry	Fixed Effects	Tobin's q is positively related to the technological assets, especially in the pharmaceutical industry
Shane and Klock [47]	1997	The relationship between patent citations and Tobin's q in the semiconductor industry	11 firms operating in semiconductor industry for the years between 1977–1990	OLS	Patent citations do not have a significant effect on Tobin's Q
Bosworth and Rogers [58]	1998	Research and development, intangible assets and performance of large Australian companies	IBIS database for the years between 1991–1993	OLS	Intangible assets are important determinants of market value.
Bharadwaj et al. [59]	1999	Information technology effects on firm performance as measured by Tobin's q	631 firms for the years between 1988–1993	Least-squares regression	For the time period investigated, IT investments had a significant positive association with Tobin's q value
Klock and Megna [49]	2000	Measuring and valuing intangible capital in the wireless communications industry	14 firms operating in the communications industry for the years between 1984–1993	OLS	Licenses and advertising explain over 60% of the variation in Tobin's q.
Gleason and Klock [51]	2003	Intangible capital in the pharmaceutical and chemical industry	All firms operating in chemical industry for the years between 1982–2001 (Compustat)	OLS	Intangible capital is a statistically significant determinant of Tobin's q and explains twenty percent of the variation.
Villalonga [9]	2004	Intangible resources, Tobin's q, and sustainability of performance differences	1641 US public operations firms between 1981–1997	Hedonic regression	From a resource-based perspective, intangibles play an effective role in sustaining a firm's competitive advantage.
Hall et al. [60]	2005	Market value and patent citations	NBER 1963–1999		Patent citations have positive effect on Tobin's q.

Table 1. *Cont.*

Author	Publication Year	Title	Data	Methodology	Results
Chin et al. [48]	2006	Patent citation, R&D spillover, and Tobin's Q: Evidence from Taiwan Semiconductor industry	Taiwanese firms between 1990–2002	OLS	The positive effect of patent citation on Tobin's Q is observed as the firm is a crucial player in the value chain.
Lin et al. [61]	2006	Patent portfolio diversity, technology strategy, and firm value	US 1985–1999	OLS	Technology stocks are used as a moderator that explains the relationship between technology diversity and firm performance. Based on the assumptions of the competence-base, firms who do not have high technology stocks should use R&D resources to develop a specific technology field.
Anandarajan et al. [62]	2008	The effect of innovative activity on firm performance: The experience of Taiwan	Semiconductor firms in Taiwanese Stock Exchange between 1990–2002	OLS	Markets tend to give greater emphasis to innovative activities when patents are granted to foreign firms by the U.S. Patent Office.
Parcharidis and Varsakelis [63]	2010	R&D and Tobin's q in an emerging market: the case of the Athens stock exchange	Greek firms for the years between 1996–2004	OLS	The Greek firms' R&D investment effect on the market value of a firm is similar to that of results from US and European studies.
Antonelli and Colombelli [64]	2011	The generation and exploitation of technological change: market value and total factor productivity	Firms in UK, Germany, France, and Italy for the years between 1995–2005	2SLS regression	TFP is a reliable indicator of firms' innovative capabilities. When we control for firm's R&D investments and intangible assets, the effects of TFP on market value remain highly significant.
Rahko [65]	2014	Market value of R&D, patents, and organizational capital: Finnish evidence	56,000 firm*year observations for the years between 1995 and 2008	NLS regression	Organizational capital, R&D, patents, and patent citations have positive and significant effects on market value.
Gamayuni [66]	2015	The effect of intangible asset, financial performance and financial policies on the firm value	Public companies in Indonesia in the years 2007–2009	OLS	Intangible assets have positive and significant effect on financial performance (ROA) and firm value.
Kumar and Sundarraj [67]	2015	Schumpeterian innovation patterns and firm performance of global technology companies	Global 1990–2009	OLS	Creative-accumulation patterns increase firm performance.
Peters and Taylor [68]	2015	Intangible capital and investment-q relation	Compustat firms	OLS	Intangible capital also generates a stronger investment-cash flow relation.

Besides these industry-specific studies, we also observed some evidence analyzing variation in Tobin's Q regarding intangible capital, which address a positive effect of intangible assets in the form of R&D, patents, patent citations, software investments, licenses, and organizational capital on firm value (see Table 1). Based on the previous evidence we determined the following hypotheses:

- H2: Firms with greater intangible assets tend to have better firm value;
- H2A: Firms with greater innovative property tend to have better firm value;
- H2B: Firms with greater computerized information and databases tend to have better firm value;
- H2C: Firms with greater economic competency tend to have better firm value.

We expect that the cumulative value of intangible assets and the sub-components of intangible assets (innovative property, computerized information and database, economic competency) have positive and significant effect on firm value if the hypotheses (H2, H2A, H2B, H2C) are supported.

3. Research Design

3.1. Sample Selection and Data Collection

Although there is no precise information regarding the total number of firms in Turkey, the listed firms in Borsa İstanbul constitute only a small part of the total number. Firms in Turkey are generally small firms and family firms. According to Turkish Statistical Institute and Organisation for Economic Co-operation and Development, as of 2015, the percentage of firms in manufacturing and services in total firms (except agricultural firms) are respectively 12% and 88%. In this research, the manufacturing covers eight main sub-sectors; food, textile, wood, chemistry, metal, machinery and equipment, transport vehicles, and furniture, while the service covers wholesale and retail trade, transport, construction, education, health, tourism, and entertainment [69]. In this paper, we examined Turkish firms listed on Borsa İstanbul to test the hypotheses. The final sample comprises 1353 observations between 2005–2013 and covers four main sectors, namely manufacturing, technology, telecommunication, and trading. The dataset starts from 2005 because, in Turkey, International Financial Reporting Standards (IFRS) have been applied since 2004, and different valuation techniques before IFRS and after IFRS may affect the results of the study. The dataset ends in 2013 because of a data access problem and difficulties with the hand-collection process. Information regarding the sub-components of intangible assets is located in the footnotes of financial statements. We reached the footnotes of financial statements of each firm and collected the information regarding which kind of intangible assets firms invest in, and then we classified these items in three sub-components following the paper by Corrado et al. [29–32]. Financial firms, holdings, firms in the extractive sector (i.e., mining), and tourism firms are excluded because they are subject to different regulations and the structure of their financial statements is slightly different. Besides, some firms did not disclose information regarding their corporate governance structures and the sub-components of intangible assets. Thus, we classified them as missing data. The total number of firms were retrieved from the Capital Market Depository of Turkey (MKK) [70] using their annual statistics. The Capital Market Depository of Turkey provides its members with registration, settlement, and custody services [70]. Besides, The Capital Market Depository of Turkey also provides information regarding the ownership structures, dividend payments, public offerings of listed firms in Borsa İstanbul. Then, we excluded the above-mentioned firms and missing data. Table 2 presents the sample selection procedure and final sample. The dataset is unbalanced.

Table 2. Sample selection procedure and final sample by year.

Panel A: Sample Selection Procedure										
Sector/Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	Tot.
Number of firms	319	335	335	335	335	352	375	418	439	3243
Excluded and missing data	238	229	223	175	168	178	189	233	257	1890
Total obs.	81	106	112	160	167	174	186	185	182	1353
Total obs./ The number of firms	25.39%	31.64%	33.43%	47.76%	49.85%	49.43%	49.6%	44.25%	41.45%	41.72%
Panel B: Final sample by year and sector										
Sector/Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	Tot.
Manufacturing	64	82	87	130	137	142	148	147	144	1081
Technology	8	11	12	13	13	15	16	16	16	120
Telecommunication	3	4	4	5	5	5	5	5	5	41
Trading	6	9	9	12	12	12	17	17	17	111
Total obs.	81	106	112	160	167	174	186	185	182	1353

Information regarding the dependent variables in the current study (sustainable growth and firm value) are obtained from the Financial Information News Network (FINNET) database [71]. FINNET database is one of the common databases which provides detailed information and updates regarding the financial statements items of listed firms in Borsa Istanbul. This database does not provide information regarding the corporate governance structures of firms. We reached data regarding the calculation of sustainable growth rates of firms from FINNET database, and then we measured the sustainable growth rates for each firm. FINNET database presents the final scores for firm value. If they are not available, we accessed the financial statements of firms to measure their sustainable growth rates and firm value. The variables of interest (intangible assets and three sub-components, namely "Computerized Information and Databases," "Innovative Properties," and "Economic Competence") were manually collected from firms' financial reports, and the footnotes of financial statements. First, the financial reports of firms were obtained from the Public Disclosure Platform of Turkey (KAP) for each year [72]. The Public Disclosure Platform of Turkey provides the listed firms' financial statements and their footnotes. Besides this platform presents the detailed information regarding merger and takeover, related party transactions, dividend payment policies of firms, credit rating, and sustainability reports [72]. Then, we reached the footnotes of financial reports regarding the intangible assets of firms. These footnotes show which kind of intangible assets firms hold. Therefore, we classified the intangible assets of firms into three sub-headings as mentioned in the paper by Corrado et al [29–32]. (Please see Section 3.2.3, for more detailed information regarding how intangible assets are classified into three sub-headings.)

Data regarding control variables such as a firm's board structure (Board Gender Diversity, Board Independency, Duality) and top management structure (Gender Diversity in Top Management) were hand-collected because there is no database that discloses the corporate governance structures of firms in Turkey. First, we reached the firms' activity reports or corporate governance compliance reports, then we determined the percentages of females and independent members on the board of directors of firms, and firms with CEO duality for each year. All activity reports and corporate governance compliance reports were retrieved from firms' websites. In the current study, top managers refer to the lists of managers who have a right to manage daily activities of the business. This information, and the percentage of females at the top management level of firms, was manually obtained from the firms' annual reports. Information regarding firm-specific control variables such as leverage, firm size, and financial performance was obtained from the FINNET database [71]. Finally, we manually calculated firm age using corporate webpages or activity reports of firms. The ownership structure (the percentage of institutional owners) of firms were retrieved from the database of the MKK [70].

3.2. Model

Ordinary least squares (OLS) is mainly used to test our hypotheses in this study. The estimation models are as follows:

$$\begin{gathered} \text{SGR}_{i,t} \text{ or } \text{SGR2}_{i,t}. \text{ (or } \text{FV}_{i,t}) = \beta_0 + \beta_1 \text{ Intangibles}_{i,t} + \beta_2 \text{ Board Female Percent}_{i,t} + \\ \beta_3 \text{ Board Independence}_{i,t} + \beta_4 \text{ Duality}_{i,t} + \beta_5 \text{ Top Female Percent}_{i,t} + \beta_6 \text{ Firm Size}_{i,t} + \\ \beta_7 \text{ Leverage}_{i,t} + \beta_8 \text{ Firm Performance}_{i,t} + \beta_9 \text{ Firm Age}_{i,t} + \beta_{10} \text{ Institutional Owner}_{i,t} + \\ \Sigma\text{Sector Dummies} + \Sigma\text{Year Dummies} + \varepsilon \end{gathered} \quad (1)$$

While the above model (1) is utilized to investigate the effect of the cumulative value of intangible assets of firms on sustainable growth rate (*SGR1* and *SGR2*) and firm value (*FV*), the below model (2) is utilized to estimate the effect of each sub-component (namely, computerized information and databases, innovative property and economic competence) of intangible assets on sustainable growth rate (*SGR1* and *SGR2*) and firm value (*FV*) of firms. The second model shows us which sub-component of intangible assets is more important in improving sustainable growth and firm value. All control variables are included in all models.

$$\begin{gathered} \text{SGR}_{i,t} \text{ or } \text{SGR2}_{i,t}. \text{ (or } \text{FV}_{i,t}) = \beta_0 + \beta 1 \text{ Computerized Info}_{i,t} + \beta 2 \text{ Innovative Property}_{i,t} \\ + \beta 3 \text{ Economic Competence}_{i,t} + \beta_4 \text{ Board Female Percent}_{i,t} + \beta_5 \text{ Board Independence}_{i,t} \\ + \beta_6 \text{ Duality}_{i,t} + \beta_7 \text{ Top Female Percent}_{i,t} + \beta_8 \text{ Firm Size}_{i,t} + \beta_9 \text{ Leverage}_{i,t} + \beta_{10} \text{ Firm} \\ \text{Performance}_{i,t} + \beta_{11} \text{ Firm Age}_{i,t} + \beta_{12} \text{ Institutional Owner}_{i,t} + \Sigma\text{Sector Dummies} \\ + \Sigma\text{Year Dummies} + \varepsilon \end{gathered} \quad (2)$$

The coefficient of β_1 in model 1 (*Intangibles*) is also expected to be positive, while the coefficients of β_1, β_2, β_3 in the model 2 (*Computerized Info*, *Innovative Property*, *Economic Competence*) are also expected to be positive.

3.2.1. Dependent Variables

Sustainable Growth

Two types of sustainable growth rate measures (*SGR1* and *SGR2*, respectively) are employed as dependent variables in this study due to enhancing the validity of results. The first rate formulated by Higgins [39] and many researchers [33,73–75] were used or modified this formula to calculate firms' sustainable growth rate in their studies. According to this formula (*SGR1*), sustainable growth reflects firm's retention policy, cost containment ability, asset utilization efficiency, and financial strategy [76]. The calculation of the first rate is as follows:

$$\text{SGR1} = \text{Profit Margin} \times \text{Asset Turnover} \times \text{Retention Ratio} \times \text{Financial Leverage} \quad (3)$$

Profit margin is calculated as net income divided by sales. Asset turnover is measured as sales divided by total assets. Financial leverage is calculated as total debts divided by total assets. Retention ratio is calculated as retained earnings divided by net income [33,39,73,77].

The second measure of sustainable growth rate (SGR2) was also used by many researchers [73,77–79]. Some researchers refer to this rate as internal growth rate in their studies [79,80]. This rate is the maximum growth rate that can be achieved without debt or equity external financing [80]. The formulation of the second rate is as follows:

$$\text{SGR2} = \text{ROE} \times \text{Retention Ratio}/1\text{- ROE} \times \text{Retention Ratio} \quad (4)$$

ROE is the return on equity which is calculated as net income divided by shareholders' equity. The calculation of retention ratio is mentioned above.

Firm Value

Firm value (*FV*) is measured as market value of assets divided by book value of assets [81,82].

$$\text{FV} = \text{Market value of assets/Book value of assets} \quad (5)$$

Book value of assets refers to the value of firm according to the balance sheet of firm, (i.e. total equity of firm), while market value of assets is calculated as the total number of shares of firms is multiplied by the price of a share. We retrieved this information from FINNET database [71].

3.2.2. Variables of Interest

Intangible assets and sub-components of intangible assets are used as the variables of interest in this study. The cumulative amount of intangible assets and sub-components of intangible assets are employed as the variables of interest. The amount of these variables refers to accumulated intangible assets and sub-components of intangible assets over the years by firms. Cumulative intangible assets (*Intangibles*) are calculated as the total amount of cumulative intangible assets divided by non-current assets. There are many classifications [60,83–88] regarding intangible assets in the earlier literature. For example, Sveiby [85] also divided intangible assets into three sub-components including employee competence and external (e.g., relationship between suppliers and customers, brandnames, trademarks, image) and internal intangibles (e.g., patents, concepts, model, computer). Kaplan and Norton [87] also classified intangible assets into three categories: human capital (skills, talent, knowledge), information capital (databases, information systems, networks), and organization capital (culture, leadership). It is difficult to score such classifications. We follow the most commonly used classification [3,16,20,21,89] made by Corrado et al. [29–32] because testing the effect of each intangible asset item can be difficult. For instance, each firm may not have to invest in or have intangible assets like motion pictures or patents, which are items in the innovative property classification. In this case, using only investments in motion pictures or patents as the variable of interest may not be meaningful due to insufficient number of observations. On the other hand, Corrado et al. [29–32], on the other hand, made this classification based on balance sheet items. Reaching the balance sheet items of firms enables us to make this classification. The disadvantage of this classification compared to the other classifications is that some items such as employee competence, human capital, customer-based capital are not considered in this classification. Thus, following the paper by Corrado et al. [29–32], each item regarding intangible assets are divided into three sub-components in this study. These are "Computerized Information and Databases," "Innovative Property," and "Economic Competence."

These sub-components still contain a number of items as follows. Computerized information and databases (*Computerized Info*), which refers to knowledge embedded in computer programs and computerized databases [30], is composed of the total cumulative amounts of software, information systems, domains, and consumer databases in this study. Innovative property (*Innovative Property*), which refers to knowledge acquired through scientific research and development and non-scientific inventive and creative activities [30], comprises the total cumulative amounts of capitalized research and development, copyrights, designs, licenses, and patents in this study. Economic competence (*Economic Competence*), which refers to knowledge embedded in firm-specific human and structural resources including brand names [30] or which covers investments to retain or gain market share [31], is composed of the total cumulative amounts of trademarks, special costs, agreements, rights, customer lists, and dealer lists in this study. All sub-components are divided by non-current assets.

More detailed information regarding the classification of sub-components of intangible assets is provided in Table 3. Fındık and Ocak [12] were used a similar classification to investigate the effect of intangible assets on firm performance (ROA) in Turkey.

Table 3. Detailed information regarding the classification of sub-components of intangible assets.

Computerized Information and Database	Innovative Property	Economic Competency
Software Computer programs Information systems Data processing Domains Customer databases	Patent Licenses Wholesale licenses Electricity generation licenses Energy generation licenses Technology licenses Mineral exploration licenses GSM and telecommunication Licenses Motion picture Films Development expenses Industrial design Depletable assets Research expenses Preparation and development Expenses Rights Water resources rights Mining rights Concession rights Land lease rights Betting rights Rights for tax exemption Irrevocable rights Slot rights	Advances given Brands Trademarks Bottling agreements Pre-operating expenses Special cost Communication networks with Dealers Customer networks Production concession Agreements Service concession agreements Dealer lists Customer lists Accumulated orders Distribution agreements Non-compete agreements Favorable lease contracts

3.2.3. Control Variables

In this study, some firm governance-specific (Board and Top Management Levels) and firm-specific control variables are employed. Institutional owner percentage is used as a control variable. Firm governance-specific variables are controlled because prior research shows that firms with good governance structure invest more in intangible assets, particularly in research and development [24,26,90–102]. Firms are also aware that good governance leads to sustainable growth and it is gaining recognition as a key factor in driving sustainable growth [103–105] and good governance leads to higher firm value [106,107]. Board independency (*Board Independence*), board female percentage (*Board Female Percent*), CEO duality (*Duality*) and females in the top management level of firms are handled as the components of corporate governance. *Board Independence* is calculated as the number of independent directors on the board of a firm divided by total number of directors. *Board Female Percent* is calculated as the total number of female directors on a firm's board divided by total number of directors. *Top Female Percent* is calculated as the total number of females in s firm's top management team level divided by total numbers of managers at top management level. *Duality* equals 1 if the chairman and CEO are the same person, 0 otherwise.

Firm structure-specific variables are also controlled in this study because recent studies documented that large firms, firms with low leveraging, profitable firms and older firms have more opportunities for sustainable growth [33,73,75,79,108,109] and these structural features of firms can be decisive for investing in intangible assets [11,26], the governance structures of firms [110]. The structural features of firms may have an effect on firm value [111]. Firm size (*Firm Size*) is the natural logarithm of total assets of a firm. Financial leverage (*Leverage*) is calculated as the total debts divided by total assets. Financial performance (*Firm Performance*) is measured as net income divided by total assets. Firm age (*Firm Age*) is the natural logarithm of the number of years since establishment. One of the types of the ownership structures of firms (institutional owners) is controlled in this study because previous studies emphasize that the ownership structures of firm may have an impact on sustainable growth [108] and firm value [112]. Institutional ownership (*Institutional Owner*) is the percentage of total shares of institutional owners. Finally, sector dummies (Sector Dummies) and year dummies (Year Dummies) are included because of their potentially unobservable effects and because, during the period investigated, Turkish

firms are exposed to the negative effects of the financial crisis. The global financial crisis in 2008 decreases financial performances [113]. To control for heteroscedasticity, we obtained robust standard errors by clustering firms.

4. Results

This section covers descriptive statistics, correlation matrix and OLS and Heckman two-stage estimation results.

4.1. Descriptive Statistics

This subheading covers basic statistics regarding variables that are used in estimation models. Table 4 presents descriptive statistics regarding variables. The mean value of *SGR1* is 0.0342. The range of values of *SGR1* varied from −0.0370 to 0.7537. The mean value of *SGR2* is 0.0032, and the range values of *SGR2* varied from −0.0574 to 0.1245. The average value of firm value (*FV*) is 2.0484, and the range of values of *FV* varied from 0 to 74.600. The mean value of *SGR1* is slightly higher than the value for sustainable growth rate which was calculated by Xu and Wang [33] and lower than the value of sustainable growth rate calculated by Feng et al. [108]. The mean value of *Intangibles* is 0.0763. The mean values regarding the sub-components of intangible assets indicate that firms have more cumulative innovative property (*Innovative Property*) (0.0547) than the other sub-components of intangible assets, namely computerized information and databases (*Computerized Info*) (0.0064) and economic competence (*Economic Competence*) (0.0163).

Table 4. Descriptive statistics.

Variable	Mean	Std. Dev.	Min	Max
SGR1	0.0342	0.0479	−0.0370	0.7537
SGR2	0.0032	0.0072	−0.0574	0.1245
FV	2.0484	3.7418	0	74.600
Intangibles	0.0763	0.1444	0	0.9859
Computerized Info	0.0064	0.0376	0	0.4620
Innovative Property	0.0547	0.1171	0	0.9857
Economic Competence	0.0163	0.0651	0	0.6580
Board Female Percent	0.1149	0.1468	0	0.8000
Board Independence	0.1075	0.1507	0	0.5000
Duality	0.0901	0.2865	0	1
Top Female Percent	0.1130	0.1460	0	1
Top Female Dummy	0.5173	0.4998	0	1
Firm Size	19.280	1.5238	15.322	23.957
Leverage	0.4943	0.4808	0.0176	8.6743
Firm Performance	0.0301	0.1444	−3.2284	1.0050
Firm Age	3.4712	0.4729	0.6931	4.6249
Institutional Owner	0.3615	0.3000	0	0.9897

Female (*Board Female Percent*) and independent member (*Board Independence*) percentages on boards are respectively 0.1149 and 0.1075. Of the observations, on average, 9.01% have CEO duality (*Duality*). The percentage of females at the top management level of firms is 11.30%. Of observations, 51.73% have a female at the top management level of firms. The average firm size is 19.280 (approximately 215 Million Turkish Lira 40 Million Dollars). The average values of leverage (*Leverage*) and financial performance (*Firm Performance*) are respectively 0.4943 and 0.0301. The mean value of firm age (*Firm Age*) is 3.4712 (Raw form of firm age is 32 years approximately). The mean value of institutional owners' percentage (*Institutional Owner*) is 0.3615.

4.2. Correlation Matrix

The correlation matrix in Table 5 is used to control multicollinearity among the variables. The results regarding correlation coefficients show that there is no multicollinearity problem among the variables. Intangible assets (*Intangibles*) are positively correlated with sustainable growth rates (*SGR1* and *SGR2*) and firm value (*FV*). The values of two sub-components (*Computerized Info* and *Economic Competence*) of cumulative intangible assets are positively correlated with the sustainable growth rates (*SGR1* and *SGR2*) and firm value (*FV*). Innovative property is only positively correlated with one type of sustainable growth rates (*SGR1*). Hence, independent members on the board of firm (*Board Independence*) is positively correlated with intangible assets (*Intangibles*) and two sub-components of intangible assets (*Innovative Property*, *Economic Competence*). On the other hand, *Duality* is negatively and significantly correlated with all sub-components of intangible assets (*Computerized Info, Innovative Property*, and *Economic Competence*). We separately ran *Intangibles* and the sub-components (*Computerized Info*, *Innovative Property*, and *Economic Competence*) in different estimation models because the total amounts of the sub-components of intangible assets may substitute for *Intangibles*.

Table 5. Correlation matrix.

Panel A: Correlation Coefficients Among Variable *SGR1* to *Board Independence*								
Variables	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
(1) SGR1	1							
(2) SGR2	0.644 ***	1						
(3) FV	0.052 *	0.0722 **	1					
(4) Intangibles	0.156 ***	0.123 ***	0.123 ***	1				
(5) Computerized Info	0.130 ***	0.087 **	0.114 ***	0.362 ***	1			
(6) Innovative Property	0.049 *	0.014	0.036	0.627 ***	0.106 ***	1		
(7) Economic Competence	0.095 ***	0.067 **	0.066 **	0.509 ***	−0.007	−0.004	1	
(8) Board Independence	−0.006	−0.035	−0.015	0.157 ***	0.037	0.133 ***	0.089 ***	1
(9) Board Female Percent	−0.021	0.026	−0.016	−0.043 *	−0.024	−0.050 *	0.026	−0.075 ***
(10) Duality	0.049 *	0.011	−0.024	−0.038	−0.051 *	0.053 *	−0.077 ***	0.033
(11) Firm Size	0.367 ***	0.194 ***	0.037	0.161***	0.137 ***	0.058 **	0.120 ***	0.110 ***
(12) Leverage	−0.015	−0.116 ***	0.152 ***	0.155***	0.022	0.147 ***	0.055 *	0.114 ***
(13) Firm Age	0.136 ***	0.137 ***	0.019	−0.100***	−0.099 ***	−0.114 ***	0.013	0.040
(14) Firm Performance	0.224 ***	0.175 ***	0.108 ***	0.033	0.039	0.001	−0.038	−0.104 ***
(15) Institutional Owner	0.298 ***	0.151 ***	0.157 ***	0.160 ***	0.155 ***	0.025	0.135 ***	0.045 *
(16) Top Female Percent	0.069 **	0.0161	−0.046	0.070 **	0.100 ***	0.056 **	0.039	0.039
Panel B: Correlation coefficients among variable *Board Female Percent* to *Top Female Percent*								
Variables	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
(9) Board Female Percent	1							
(10) Duality	0.072 **	1						
(11) Firm Size	−0.159 ***	−0.104 ***	1					
(12) Leverage	−0.094 ***	−0.010	0.129***	1				
(13) Firm Age	−0.011	−0.016	0.191***	−0.023	1			
(14) Firm Performance	−0.025	−0.040	0.263***	−0.399 ***	0.058 **	1		
(15) Institutional Owner	−0.090 ***	0.002	0.584***	0.006	0.075 ***	0.222 ***	1	
(16) Top Female Percent	0.145 **	0.056 **	-0.069**	−0.003	−0.003	−0.024	−0.030	1

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

4.3. Main Estimation Results

This sub-heading presents the OLS estimation results. Table 6 presents the effects of intangible assets (*Intangibles*) and the sub-components of intangible assets (namely, *Computerized Info*, *Innovative Property*, and *Economic Competence*) on sustainable growth (SGR1 in column 1 and 4 and *SGR2* in column 2 and 5) and firm value (*FV* in column 3 and 6). We obtained robust standard errors by clustering firms to control for heteroscedasticity. Besides, we tested the normality of the data and the results of these assumption show that the data is normally distributed.

Table 6. Main estimation results.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	SGR1	SGR2	FV	SGR1	SGR2	FV
Intangibles	0.0237 ***	0.168 **	0.310 *			
	(0.00789)	(0.0690)	(0.163)			
Computerized Info				0.101 ***	0.856 ***	1.506 **
				(0.0285)	(0.295)	(0.607)
Innovative Property				−0.00358	0.0320	−0.0732
				(0.00943)	(0.0789)	(0.194)
Economic Competence				0.0272 *	0.259 *	0.579 *
				(0.0162)	(0.136)	(0.330)
Board Independence	−0.00749	−0.142	−0.240	−0.00542	−0.0640	−0.172
	(0.0116)	(0.103)	(0.249)	(0.0116)	(0.102)	(0.249)
Board Female Percent	0.00881	0.236 ***	−0.0550	0.00829	0.217 ***	−0.0524
	(0.00780)	(0.0676)	(0.170)	(0.00782)	(0.0669)	(0.170)
Duality	0.00960 **	0.0362	−0.0629	0.0104 ***	0.0408	−0.0531
	(0.00377)	(0.0331)	(0.0769)	(0.00380)	(0.0330)	(0.0776)
Top Female Percent	0.00898	−0.0388	0.352 **	0.00840	−0.0513	0.324 *
	(0.00762)	(0.0661)	(0.165)	(0.00771)	(0.0656)	(0.167)
Firm Size	0.00707 ***	0.0565 ***	−0.109 ***	0.00698 ***	0.0606 ***	-0.108 ***
	(0.000936)	(0.00808)	(0.0205)	(0.000936)	(0.00969)	(0.0205)
Leverage	−0.00541 **	−0.0611 ***	0.906 ***	−0.00449 *	−0.117 **	0.924 ***
	(0.00238)	(0.0180)	(0.121)	(0.00239)	(0.0502)	(0.123)
Firm Age	0.00750 ***	0.0412 *	0.126 **	0.00821 ***	0.0482 **	0.134 **
	(0.00249)	(0.0216)	(0.0532)	(0.00250)	(0.0213)	(0.0534)
Firm Performance	−0.0240 ***	0.0974 ***	1.543 ***	−0.0226 ***	0.791 ***	1.642 ***
	(0.00830)	(0.0375)	(0.300)	(0.00836)	(0.156)	(0.304)
Institutional Owner	0.0255 ***	0.0715 *	0.635 ***	0.0256 ***	0.0455	0.621 ***
	(0.00444)	(0.0384)	(0.0960)	(0.00444)	(0.0379)	(0.0960)
Constant	−0.135 ***	−1.039 ***	2.587 ***	−0.136 ***	−1.140 ***	2.544 ***
	(0.0183)	(0.157)	(0.390)	(0.0184)	(0.183)	(0.392)
Year Fixed	Yes	Yes	Yes	Yes	Yes	Yes
Sector Fixed	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1353	1353	1353	1353	1353	1353
F Value	15.00 ***	8.17 ***	12.57 ***	14.05 ***	9.38 ***	11.56 ***
R^2	0.200	0.129	0.189	0.206	0.157	0.192
Test of Normality						
Jarque-Bera	4.519	4.743	0.7433	4.416	3.891	2.263
Chi2	0.1044	0.0933	0.6896	0.1099	0.1429	0.3225

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, Standard errors in parentheses.

Table 6 shows that the intangible assets positively and significantly affect sustainable growth rates of firms (*SGR1* and *SGR2*) (Column 1: 0.0237 and Column 2: 0.168). Moreover, the intangible assets of firms (*Intangibles*) affect firm value (*FV*) positively and significantly (Column 3: 0.310). We accept H1 and H2. The same table shows that computerized information and databases (*Computerized Info*) and economic competence (*Economic Competence*) are positively and significantly related to the rates of sustainable growth (*SGR1* and *SGR2*) (Column 4: 0.101; 0.0272 and Column 5: 0.856; 0.259). Besides, computerized information and databases (*Computerized Info*) and economic competence (*Economic Competence*) are positively and significantly associated with firm value (*FV*) (Column 6: 1.506, 0.579). We accept H1B, H1C, H2B, and H2C. It was found that innovative property (*Innovative Property*) had no effect on sustainable growth rates (*SGR1* and *SGR2*) and firm value (*FV*) (Column 4: −0.00358; Column 5: 0.0320; Column 6: 0.0732). Thus, we do not accept H1A and H2A. The magnitudes of coefficients (0.101 and 0.856 and 1.506 vs 0.0272 and 0.259 and 0.579) show that the computerized information and databases (which includes software, information systems, domains, and consumer databases) is a more important element than economic competence (which includes brand names,

trademarks, special costs, agreements, rights, customer lists, dealer lists) to enhance sustainable growth and firm value. On the other hand, the reason for the insignificant association between innovative property (*Innovative Property*) and sustainable growth (*SGR1* and SGR2) and firm value (*FV*) is exposed when the context of the sub-component of innovative property (*Innovative Property*) is investigated (please see the Section 3.2.3). The sub-component of intangible assets *Innovative Property* comprises capitalized research and development, copyrights, designs, licenses, and patents. The research and development item in the innovative property classification is highly risky and the return on this item may spread over years [93]. Many patents in the innovative property classification may provide only limited protection and be created for strategic purposes only distantly related to firm's own innovation efforts [11,73,114]. Thus, innovative property may not affect sustainable growth and firm value for this reason.

The results regarding control variables are as follows. While the percentage of independent members on the boards of firms (*Board Independence*) negatively but insignificantly affected sustainable growth rates (*SGR1* and SGR2) and firm value (*FV*) (−0.00749, −0.142, −0.240, −0.00542, −0.0640, and −0.172, respectively) in all columns, the percentage of females on the boards of firms (*Board Female Percent*) significantly and positively influences sustainable growth rate 2 (SGR2) (Column 2: 0.236; Column 5: 0.217). CEO duality (*Duality*) is positively and significantly associated with sustainable growth rate 1 (*SGR1*) (Column 1: 0.00960; Column 4: 0.0104). The percentage of females in top management positions significantly and positively affects only firm value (*FV*) (Column 3: 0.352; Column 6: 0.324). The results show that the percentage of institutional owners (*Institutional Owner*) (0.0255, 0.0715, 0.635, 0.0256, and 0.621, respectively) and firm age (*Firm Age*) (0.00750, 0.0412, 0.126, 0.00821, 0.0482, and 0.134, respectively) generally have positive and significant effects on sustainable growth rates (*SGR1* and *SGR2*) and firm value (*FV*). While firm leverage (*Leverage*) negatively and significantly affects the sustainable growth rates (*SGR1* and *SGR2*) (−0.0541, −0.0611, −0.00449, and −0.117, respectively), it has a positive and significant effect on firm value (*FV*) (0.906 and 0.924). On the other hand, firm size (*Firm Size*) has a negative and significant effect on firm value (*FV*) (−0.109 and −0.108), and it positively and significantly affects the sustainable growth rates (*SGR1* and *SGR2*) (0.00707, 0.0565, 0.00698, and 0.0606, respectively).

4.4. Heckman Estimation Results

Some recent studies, especially studies in Turkey, indicate that females at the top management level of firms are more likely to invest in intangible assets, particularly in R&D and the innovative property type of intangible assets [26,27]. (In the current study, the correlation table also shows that females at top management level (*Top Female Percent*) positively and significantly correlated with intangible assets and the sub-components of intangible assets.) These studies assert that females are more innovative than males [99] and they may bring more innovative ideas such as intangible assets to a firm [24]. Thus, female participation at the top management level of firms affects firms' intangibles and it indirectly affects sustainable growth of firms and firm value. We adopted a model with some firm-specific characteristics as the determinants of female participation at the top management level of firms. The first stage of the Heckman two-stage estimation model is as follows:

$$\begin{aligned} \text{Top Female Dummy}_{it} = {} & \beta_0 + \beta_1 \text{ Board Female Percent}_{i,t} + \beta_2 \text{ Board Independence}_{i,t} \\ & + \beta_3 \text{ Duality}_{i,t} + \beta_4 \text{ Firm Size}_{i,t} + \beta_5 \text{ Leverage}_{i,t} + \beta_6 \text{ Firm Performance}_{i,t} \\ & + \beta_7 \text{ Firm Age}_{i,t} + \beta_8 \text{ Institutional Owner}_{i,t} + \Sigma\text{Sector Dummies} + \Sigma\text{Year Dummies} + \varepsilon \end{aligned} \quad (6)$$

In the first stage of the Heckman two-stage estimation procedures, we determined which firms are more likely to have females at their top management level. Even though discussions on the appointment of a female to the top levels of firms refers to the board of directors of firms, we argue that these discussions are valid for top management level of firms. Thus, we used some board-specific attributes and firm-specific characteristics in the first stage of selection model. Prior literature stated that female managers and boards with more independent directors are more likely to hire females [115,116]. Besides, CEO who holds the board chairperson may enforce the female participation [117,118]. While large firms may face more pressure to appoint females to the top levels of firms, old firms have more conservative structure and they are less likely to appoint females to top levels of firms [118,119] and higher percentage of institutional owners increases the female presence [118]. We controlled firm performance because presentation of females in top levels of firms increases the performance of firms, thus firms with high performance are more likely to present on top levels of firms [120]. We used sector and year fixed effects because of potential effects. After calculation of the inverse Mills ratio (*IMR*), we re-ran our OLS models with the addition of the *IMR*. *Top Female Dummy* is equal to 1 if there is a female in the top managements of firms, 0 otherwise. Other variables in the first stage of the Heckman two-stage estimation model are explained above. The results of the first stage of Heckman two-stage estimation model shows that high leveraged firms and firms with high board gender diversity are more likely to hire females at the top management levels. However, firms with high board independence are less likely to hire females at the top management level. The second stages of Heckman two-stage estimation models are as follows:

$$\begin{aligned} \text{SGR1}_{i,t} \text{ or } \text{SGR2}_{i,t} \text{ (or } \text{FV}_{i,t}) &= \beta_0 + \beta_1 \text{ Intangibles}_{i,t} + \beta_2 \text{ Board Female Percent}_{i,t} \\ &+ \beta_3 \text{ Board Independence}_{i,t} + \beta_4 \text{ Duality}_{i,t} + \beta_5 \text{ Top Female Percent}_{i,t} + \beta_6 \text{ Firm Size}_{i,t} \\ &+ \beta_7 \text{ Leverage}_{i,t} + \beta_8 \text{ Firm Performance}_{i,t} + \beta_9 \text{ Firm Age}_{i,t} + \beta_{10} \text{ Institutional Owner}_{i,t} \\ &+ \text{IMR} + \Sigma\text{Sector Dummies} + \Sigma\text{Year Dummies} + \varepsilon \end{aligned} \quad (7)$$

$$\begin{aligned} \text{SGR}_{i,t} \text{ or } \text{SGR22}_{i,t}. \text{ (or } \text{FV}_{i,t}) &= \beta_0 + \beta_1 \text{Computerized Info}_{i,t} + \beta_2 \text{Innovative Property}_{i,t} \\ &+ \beta_3 \text{Economic Competence}_{i,t} + \beta_4 \text{ Board Female Percent}_{i,t} + \beta_5 \text{ Board Independence}_{i,t} \\ &+ \beta_6 \text{ Duality}_{i,t} + \beta_7 \text{ Firm Size}_{i,t} + \beta_8 \text{ Leverage}_{i,t} + \beta_9 \text{ Firm Performance}_{i,t} + \beta_{10} \text{ Firm} \\ &\text{Age}_{i,t} + \beta_{11} \text{ Institutional Owner}_{i,t} + \text{IMR} + \Sigma\text{Sector Dummies} + \Sigma\text{Year Dummies} + \varepsilon \end{aligned} \quad (8)$$

The other columns (2, 3, 4, 5, 6, and 7) in Table 7 present the results regarding the second stage of Heckman two-stage estimation. Intangible assets positively and significantly affect the sustainable growth of firms (*SGR1* and *SGR2*) (Column 2: 0.0250; Column3: 0.357) and firm value (*FV*) (Column4: 0.338). Besides, we found that the sub-components of intangible assets, computerized information and database have a positive and significant impact on sustainable growth rates (*SGR1* and SGR2) and firm value (*FV*) (Column 5: 0.0976; Column 6: 0.823; Column 7: 1.727). On the other hand, economic competence affects only one type of sustainable growth rate (*SGR1*) and firm value (*FV*) (Column 5: 0.0279 and Column 7: 0589). We found no association among innovative property, sustainable growth rates and firm value as in the OLS estimation results. The results of the Heckman two-stage estimation procedure generally confirm the results of the OLS estimation procedure.

Table 7. Heckman estimation results.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	**Top Female Dummy**	**SGR1**	**SGR2**	**FV**	**SGR1**	**SGR2**	**FV**
Intangibles		0.0250 ***	0.357**	0.338**			
		(0.0078)	(0.141)	(0.161)			
Computerized Info					0.0976 ***	0.823 **	1.727 ***
					(0.0307)	(0.327)	(0.639)
Innovative Property					−0.00373	0.0248	0.0443
					(0.00953)	(0.0809)	(0.196)
Economic Competence					0.0279 *	0.208	0.589 *
					(0.0162)	(0.137)	(0.327)
Board Independence	−1.0203 **	−0.0077	−0.0423	−0.239	−0.00549	−0.132	−0.191
	(0.3944)	(0.0116)	(0.2086)	(0.247)	(0.0116)	(0.103)	(0.247)
Board Female Percent	1.2148 ***	0.0072	0.2861 **	−0.0773	0.00785	0.234 ***	−0.0830
	(0.2712)	(0.0077)	(0.1404)	(0.168)	(0.00784)	(0.0680)	(0.169)
Duality	0.0780	0.0090 **	0.0634	−0.0751	0.0102 ***	0.0403	−0.0615
	(0.1264)	(0.0037)	(0.0677)	(0.0763)	(0.00380)	(0.0335)	(0.0770)
Top Female Percent	–	0.0080	0.0424	0.345 **	0.00759	−0.0414	0.316 *
		(0.0076)	(0.1375)	(0.163)	(0.00774)	(0.0671)	(0.166)
Firm Size	−0.0076	0.0033	−0.1267 *	−0.475 ***	0.00340	−0.0129	−0.461 ***
	(0.0288)	(0.0026)	(0.0713)	(0.0975)	(0.00306)	(0.0345)	(0.100)
Leverage	0.2106 **	0.0078	0.3795 *	2.379 ***	0.00879	0.159	2.326 ***
	(0.1029)	(0.0069)	(0.2175)	(0.405)	(0.00792)	(0.105)	(0.413)
Firm Age	0.1101	0.0190 ***	0.5377 ***	1.020 ***	0.0164 ***	0.179 ***	0.991 ***
	(0.0846)	(0.0055)	(0.1416)	(0.217)	(0.00535)	(0.0684)	(0.223)
Firm Performance	−0.4540	−0.0219 ***	0.1693 **	1.987 ***	−0.0211 **	0.127 ***	2.062 ***
	(0.3782)	(0.0083)	(0.0837)	(0.318)	(0.00840)	(0.0391)	(0.322)
Institutional Owner	0.1926	0.0396 ***	0.8493 ***	1.831 ***	0.0398 ***	0.306 **	1.767 ***
	(0.1416)	(0.0080)	(0.2477)	(0.328)	(0.00918)	(0.121)	(0.338)
IMR	–	0.1038 **	4.086 **	8.674 ***	0.106 *	1.764 **	8.289 ***
		(0.0533)	(1.740)	(2.307)	(0.0629)	(0.843)	(2.374)
Year Fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector Fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	−0.8829 **	−0.226 ***	−3.996 ***	−3.832 **	−0.219 ***	−2.243 ***	−3.548 **
	(0.3663)	(0.0387)	(1.207)	(1.681)	(0.0410)	(0.585)	(1.723)
Observations	1,353	1,353	1,353	1,353	1,353	1,353	1,353
F Value	73.41 ***	14.42 ***	7.45 ***	13.21 ***	13.44 ***	7.50 ***	12.17 ***
Pseudo R^2 & R^2	0.0401	0.201	0.115	0.205	0.206	0.135	0.208

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, Standard errors in parentheses.

5. Discussion

This aim of this is to analyze the effects of intangible assets and sub-components of intangible assets, namely computerized information and databases, innovative property, and economic competence, on firm value and the sustainable growth of firms listed on Borsa İstanbul from 2005 to 2013. Two different estimation procedures of the OLS and Heckman two-stage are used to test the hypotheses.

Based on OLS and Heckman estimation results, intangible assets have an impact on sustainable growth and firm value. Also, two sub-components of intangible assets, namely computerized information and databases and economic competence, affect the sustainable growth rates of firms and firm value positively and significantly. We found no association between the other sub-component of intangible assets, innovative property, with the sustainable growth of firms and firm value.

A possible explanation for this is that innovative property comprises R&D items and the return on this item may spread over years [93]. Many patents in innovative property classification may provide only limited protection and be created for strategic purposes only distantly related to firm's own innovation efforts [11,73,114]. Thus, based on our research, innovative property does not have an impact on sustainable growth rates of firms and firm value.

The findings of the research imply that managers of firms should take into account the importance of intangible assets for sustainable growth and firm value and thus, they should know that more investment in these kinds of strategic assets will increase the success of a firm. As far as the relationship

between computerized information and databases and performance indicators is concerned, firms through investing in this subcomponent need to improve the skills of the current employees or hire new ones to increase performance improvement effect of the computerized information and databases. Additionally, investing in these assets will necessitate the changes in the organization of the work. For instance, some specific operations that require a long time to complete will be implemented in a shorter time, thus firms will be able to discover new markets.

The study has some limitations. First, a small sample was used compared to a similar study by Xu and Wang [33]. Second, the sample covers only nine years between 2005 and 2013. Most of the data was collected by hand. Data access problems and the hand-collection process caused us to work with this data.

Future research may use a larger sample and could extend the year range or may add alternative corporate governance characteristics, firm-specific characteristics or alternative sustainable growth measures to the research model. The hypotheses of the study may be tested using data from different countries. Therefore, the effects of the amounts of important items in each sub-component of intangible assets such as software, brands, and trademarks on sustainable growth and firm value may be tested. Lagged values for the sub-components of intangible assets, particularly innovative property, may be used as test variables in future research. Alternatively, the effect of different classification made by some authors [60,84–88] on firm value of the sustainable growth of firms may be tested in the future study.

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