Argumenta Oeconomica
Year 2024, Vol. 53, No. 2
ISSN 2720-5088
journals.ue.wroc.pl/aoe

Nonpayers also matter. On Lintner's dividend partial adjustment model estimation

Mieczysław Kowerski

Institute of Finance and Accounting, The Academy of Zamość, Poland

e-mail: mieczyslaw.kowerski@akademiazamojska.edu.pl

ORCID: 0000-0002-2147-2037

Quote as: Kowerski, M. (2024). Nonpayers also matter. On Lintner's dividend partial adjustment model estimation. *Argumenta Oeconomica*, 2(53), 32-51.

DOI: 10.15611/aoe.2024.2.03

JEL: C1, C23, C25, G35

Abstract: The dividend partial adjustment model proposed by J. Lintner (1956) is still one of the most widely used tools for analysing the dividend policy of companies. This model should be estimated only on the basis of observations in which dividend payments were recorded. This causes the sample selection to be not random and so the parameters estimator of the Lintner's model to be inconsistent. However, the level of the payouts of the companies selected for the Lintner's model may be affected by the decisions of dividend nonpayers not selected for this model. Some authors noted this contradiction, but there are no effective methods to solve it. In the article, to solve this problem, the Heckman (1976) sample self-selection model was proposed, which consists of two equations: the participation equation, which is a probit model of the propensity to pay dividends, and the outcome equation, which is Lintner's partial adjustment model. This was examined using an unbalanced panel of 112 companies listed on the Warsaw Stock Exchange. The results of the estimation of the Heckman model confirm that the inclusion of information about companies not paying dividends in the Lintner's model results in a significant reduction of the dividend target payout ratio and speed of adjustment. Estimated target dividend payout ratio and the speed adjustment for the entire market may be important information for companies' management when developing their own dividend policies.

Keywords: Lintner's model, Heckman's model, dividend nonpayers, unbalanced panel, Warsaw Stock Exchange

1. Introduction

In 1956, J. Lintner, after interviewing some boards of American companies, formulated a partial adjustment model which describes the relationship between the dividend paid for a given year and the income for that year along with the dividend paid for the previous year. The model makes it possible to identify the long-term dividend policy of a company by setting a target dividend payout ratio and speed of adjustment.

The model proposed by Lintner has achieved wide recognition among financial theoreticians and practitioners, and for over 60 years, the results of its estimates for different periods, companies and financial markets of many countries have been published. Over time, the Lintner's model has undergone a number of modifications, such as its extension with further variables (Fama and Babiak, 1968), (Fama and French, 2002), the introduction of other indicators describing income instead of net profit (cash flow, operating profit), and, above all, the growing number of analysed companies and the transition from a pooled approach to a panel approach.

When estimating the Lintner's model, only those observations in which a dividend payment was recorded should be taken into account. This assumption causes the sample selection to be not random, and so the parameters estimator of the Lintner's model to be inconsistent. Nonetheless, the level of the payouts of the companies selected for the Lintner's model may be affected by the decisions of nonpayers not chosen for this model. In other words, companies paying dividends can set the level of payouts depending on the number and characteristics of companies that do not pay dividends. Only a few authors noticed this problem, but still no effective methods to solve it were found. The question arises: can the contradiction between the need to use only observations on dividend payments for estimating the Lintner's model and the possible impact of information about the lack of payments by other companies be resolved?

In the article, Heckman's (1976) sample self-selection model was proposed to solve the problem. This model consists of two equations: the participation equation, which is a probit model of the propensity to pay dividends, and the outcome equation, which is Lintner's partial adjustment model.

This proposition was examined using the data from companies listed on the Warsaw Stock Exchange (WSE). For this purpose, a database of domestic companies was constructed, excluding banks, which at the end of 2019 were part of the WIG20, mWIG40 and sWIG80 indices and had been listed for at least three years. In this way, an unbalanced panel of 112 companies listed on the WSE in the period 1998-2019 or for a shorter time, i.e., from the year of entry to the end of 2019, was created. The panel consisted of 1509 observations.

The Maximum Likelihood (ML) method to estimate the participation equation and the Generalised Method of Moments (GMM) to estimate the outcome equation were used.

2. Literature review

Lintner (1956) conducted detailed field studies with the boards of directors of 28 companies (two to five management board members, including the president, vice president responsible for finance, treasurer, auditor, and directors) on their dividend policy. From these companies, he collected financial data from 1947 to 1953, receiving 196 company-years of dividend activity. Lintner's interviews show that, according to management board members, dividends are very important for shareholders, and shareholders are not so much concerned with the level of dividends paid as they are with a reasonable, stable ratio of their payment. The belief that the market rewards a stable dividend payout ratio is so strong that managers are very reluctant either to make decisions to increase the payout ratio that could be reduced in the future or to reduce the payout ratio (Lintner 1956, p. 99). This conservatism makes dividend policy sticky. This, in turn, results in the fact that management boards in a given year change dividends, only partially taking into account changes in the financial results obtained. Further partial changes in dividends are introduced in the subsequent years if the company's financial situation continues to develop in the previously anticipated direction. This policy of partial adjustments leads to the stabilisation of dividend payments and minimises adverse shareholder reactions (Lintner 1956, p. 100).

The results of the interviews with the management boards regarding the dividend policy allowed Lintner to formulate the following conclusions:

- companies apply long-term target dividend payment ratios,
- company management focuses more on changes in the dividend than on its relative value,
- changes in the dividends paid follow long-term changes in the level of net profit generated, gradually adjusting to it (*dividend smoothing*); it is unlikely that short-term changes in profits can affect the payment of dividends,
- management boards are reluctant to decide to change the level of dividends.

The above conclusions led Lintner (1956, pp.107-109) to propose the partial adjustment model, which for panel data has the following form:

$$D_{it} = \alpha_0 + \alpha_1 D_{it-1} + \alpha_2 P_{it} + \varepsilon_{it}, \quad (1)$$

where D_{it} – dividend paid by *i*-th company for fiscal year t, D_{it-1} – dividend paid by *i*-th company for fiscal year t-1, P_{it} – profit the fiscal year t of *i*-th company, ε_{it} – random disturbances, $i = 1, 2, \ldots\ldots, N$ – number of analysed companies, $t = 1, 2, \ldots\ldots, T$ – number of years under studies. The values of the estimated parameters should be proper fractions.

Equation (1) allows for calculating the target dividend payout ratio:

$$TDPR = \frac{\alpha_2}{1-\alpha_1} \cdot 100\% \quad (2)$$

and the speed of adjustment ratio:

$$SOA = (1 - \alpha_1) \cdot 100\%, \quad (3)$$

where $\alpha_1 \cdot 100\%$ – dividend smoothing ratio.

TDPR is the dividend payout ratio that the companies in the panel strive for. If the panel includes all (or representative) companies from the analysed market, TDPR is the target dividend payout ratio for the entire market. If panel companies belong to one sector, TDPR is the target dividend payout ratio in that sector. In turn, the speed of adjustment informs how quickly a given market (sector) will reach the target dividend payout ratio.

Although Lintner had a balanced panel of 196 observations of dividends paid and profits, he did not estimate the model parameters on individual data, and instead estimated two models of partial adjustment on aggregated data from 1918 to 1941 with different definitions of profit. In the first model TDPR was 50.0%, and in the second model it was 68.4%, with SOA estimated at 30.0% and 21.2%, respectively.

Lintner's 1956 publication gave rise to a whole wave of research using the partial adjustment model. One can risk the hypothesis that this is one of the most commonly used tools for analysing payout policy. Naturally, it is impossible to present a complete review of the publications, and this is why this review is limited to articles that, in the author's opinion, had a significant impact on the development of the model and are also useful from the point of view of the formulated hypothesis.

The first Lintner's model on individual data was estimated by Fama and Babiak (1968), using a panel of 392 American major industrial companies over 19 years (1946-1964). Although the authors did not specify whether all the observations concerned dividend payments, it can be assumed that in the vast majority of cases, they did. This is evidenced by the fact that, according to Fama and French (2001, p. 6), between 1943 and 1962, more than 82% of nonfinancial and nonutility companies (so-called industrial) listed on the NYSE paid dividends, compared to over 90% between 1951 and 1952. Fama and Babiak (1968) estimated the models based on major companies' data, which are usually characterised by a much higher propensity to pay dividends than other companies. Later, in the research on dividend policy, the analysis of industrial companies was adopted as a standard.

In subsequent studies, only some authors adhered to the principle that the Lintner's model should be estimated on the basis of data only from companies that pay dividends continuously. Examples include Lintner's models estimated by:

- Nakamura (1989) for 836 US companies from 1964 to 1982 and 652 Tokyo and Osaka Stock Exchanges companies from 1960 to 1981;
- Grullon and Michaely (2002), based on data from companies listed on US stock exchanges between 1973 and 1990;
- Aivazian et al. (2003) for companies in eight emerging markets from 1981 to 1990, and for US companies from 1991 to 1999. Two estimates were made for each country: the first on the basis of all companies and the second for companies continuously paying dividends;
- Gugler and Yurtoglu (2003) for 266 German major companies listed between 1992 and 1998;
- Gupta et al. (2011) for 172 industrial companies listed on the Bombay Stock Exchange between 2004 and 2008;
- Kowerski and Wypych (2016) for 71 companies listed in 2012-2016 on the WSE (main and alternative markets);
- Asimakopoulos et al. (2021) for US companies listed on the S&P500 from 1951 to 2017.

These authors, however, did not note the problem of sample self-selection bias. However, in the vast majority of studies, the authors assumed dividend payments only for a certain subperiod throughout the analysed period. Examples include Lintner's models estimated by:

- Sura et al. (2006) for 33 Indian banks listed between 1996 and 2006 that paid at least one dividend during that time;
- von Eije and Megginson (2008) for 291 companies of 15 'old EU' countries that paid cash dividends at least every five years in the 10-year period (1996–2005);
- Skinner (2008) for 345 US companies between 1980 and 2005 that made at least 16 dividend payments during that time;
- Chemmanur et al. (2010) for 153 companies listed on the Stock Exchange of Hong Kong and 603 companies listed on US stock exchanges between 1984 and 2002 that made at least seven dividend payments during that time;
- Leary and Michaely (2011) for 1335 companies listed on the NYSE between 1985 and 2005 that made at least ten dividend payments during that time;
- Jeong (2013) for 732 companies listed on the Korea Stock Exchange between 1981 and 2012 that made at least 15 payments during that time and recorded a positive financial result in each year in which the dividend was paid;
- Javakhadze et al. (2014) for 2219 companies from 24 countries (excluding the US) between 1999 and 2011 that have made at least ten continuous payments during that time;
- Shinozaki and Uchida (2014) for 6311 companies from 28 countries between 2001 and 2011 that made at least five payments during that time;
- Majumdar (2016) for 15 FMCG companies listed on the National Stock Exchange of India from 2003 to 2012 that paid dividends in two consecutive years;
- Mrzygłód et al. (2020) for 339 companies from eight countries from developing markets between 1995 and 2015, which during that time paid dividends continuously for at least six years;
- Balli et al. (2022) for 893 companies from 50 countries listed on US stock exchanges between 1995 and 2017, which during that time paid dividends continuously for at least five years.

However, the authors did not state why they chose continuous payments, e.g., for ten years rather than nine or eleven.

Some researchers did not impose any restrictions on dividend payments and estimated models based on data from all companies, including nonpayers. Examples include Lintner's models estimated by:

- Ahmed and Javid (2009) for 320 companies listed on the Karachi Stock Exchange between 2001 and 2006;

- Alzahrani and Lasfer (2009) for 9806 companies from 24 OECD countries listed between 2000 and 2007;
- Al-Najjar and Belghitar (2012) for 432 UK companies listed between 1991 and 2007;
- Andres et al. (2015) for 432 large companies listed on the Frankfurt Stock Exchange between 1998 and 2008. However, only 5.6% of the observations did not concern dividend payments;
- Bremberger et al. (2016) for 106 energy service companies from 14 EU countries between 1986 and 2010;
- Renneboog and Szilagyi (2020) for 150 Dutch companies listed on Euronext Amsterdam and NMAX between 1996 and 2004. At the same time, dividend payers accounted for 78.8% of all companies.

Such a diverse, and in many cases inconsistent with the assumptions of the Lintner's model sample selection, affects the results of its estimation and makes it difficult to compare the estimated models from different countries and periods. Nevertheless, attempts of such comparisons have been made. In recent times, the widest by Fernau and Hirsch (2019), who used a regressive meta-analysis of the estimates of 979 Lintner's models published in 99 papers selected from 407 papers published since 1957. The authors' regression meta-analysis of Lintner's models allowed to conclude that the speed of adjustment varies depending on the region for which the research was conducted, the sectors of the economy in which the companies operate and the time of the analysis. With the inclusion of all control variables and the use of GMM as an estimation technique, the calculations carried out by the authors determined the speed of the adjustment ratio for nonfinancial companies at 46.4% (Fernau and Hirsch 2019, p. 265).

For the purposes of this paper, the author analysed the estimation results of Lintner's models in 24 articles and compared the speed of adjustment (SOA) and target dividend payout ratios (TDPR) in different countries (table 1). The results are very diverse, which was probably also influenced by the sample selection used in individual studies. Some regularities concern only SOA, which is significantly lower (Student *t*-test) in the USA and in the countries of the 'old EU' than in countries from developing markets. This means that developed market companies are better able to meet Lintner's assumption about a long-term gradual adjustment of dividends to changing profits. In the case of companies from developing markets, short-term changes in profits are much more likely to determine dividend payments, whereas the TDPR does not differ significantly in these three groups of countries.

Lintner's model underwent various modifications. Fama and Babiak (1968) proposed:

- replacing net profit as a variable describing income by cash flow, which is the sum of net profit and depreciation and shows free funds at the disposal of the company,
- extending model by another variable – depreciation,
- extending model with an additional variable in the form of one year lagged net profit (full adjustment model),
- removing the constant.

Fama and Babiak (1968) concluded that cash flow could be as good a variable describing income as net profit. Similar conclusions were reached by, among others (Allen et al., 2000), (Andres et al., 2009) and (Renneboog and Szilagyi, 2020). Fernau and Hirsch (2019) found that in 11.3% of the models, cash flow was used as an explanatory variable instead of net profit. Removing the constant and adding the lagged net profit leads only to a slight improvement in the quality of the model.

Fama and French (2002) introduced three more modifications. First, they proposed an analysis of dividend payments including debt, constructing a two-equation model. Second, they introduced additional control variables into the Lintner's model, such as profitability, investment opportunities, profit volatility, and tax shield. Third, they introduced nonlinearity.

Table 1. Estimated values of the target dividend payout ratios and speed of adjustment ratios in selected studies

Authors		SOA (%)		TDPR (%)
USA				
Fama and Babiak (1968)		36.6		45.9
Nakamura (1989)		22.3*		39.0*
Grullon and Michaely (2002)		20.8		44.2
Fama and French (2002)		33.0*		33.0*
Aivazian et al. (2003)		24.9		96.4
Skinner (2008)	1980-1994	18.0	1980-1994	68.8
	1995-2005	29.0	1995-2005	62.1
Chemmanur et al. (2010)		63.2		5.5
Leary and Michaely (2011)		14.0		
Asimakopoulos et al. (2021)		29.0		23.8
Mean		29.1		46.5
Variability coefficient (%)		47.5		57.2
Countries of "old EU" (15)				
Gugler and Yurtoglu (2003) Germany		29.1*		25.3*
von Eije and Megginson (2008) 15 countries	1996-2000	54.7	1996-2000	46.3
	2001-2005	39.2	2001-2005	53.8
Al-Najjar and Belghitar (2012) Great Britain		26.3		36.7
Andres et al. (2015) Germany		31.9		48.3
Bremberger et al. (2016) 14 countries		52.5		32.8
Renneboog and Szilagyi (2020) Netherlands		20.8*		33.1*
Mean		36.4		39.5
Variability coefficient (%)		35.9		25.8
Countries from developing markets				
Aivazian et al. (2003) 8 countries		38.7*		20.4*
Sura et al. (2006) India		48.7		13.5
Ahmed and Javid (2009) Pakistan		77.0		32.5
Chemmanur et al. (2010) Hong-Kong		71.6		37.8
Gupta et al. (2011) India		83.9*		60.7*
Jeong (2013) South Korea		68.8		13.2
Majumdar (2016) India		57.7		10.9
Kowerski and Wypych (2016) Poland		86.7		52.8
Mrzygłód et al. (2020) 8 countries		68.0*		47.1*
Mean		66.8		32.1
Variability coefficient (%)		23.8		58.2

*average from many models

Source: own elaboration.

The modifications also concerned the estimation methods of the Lintner's model, which is autoregressive (dynamic), and the Ordinary Least Squares (OLS) method used by Lintner, due to the correlation of the lagged dependent variable with the disturbances, is not the most appropriate method. For some time, the Fama-McBeth method (1973) was very popular, and recently, in the case of panel data, the Generalised Method of Moments (GMM) of Arellano and Bond (1991) has been mainly used for the estimation of the Lintner's model.

In 2001, Fama and French published a seminal paper in which they tried to identify the factors causing the decline in the propensity of US listed companies to pay dividends for the last 35 years. For this purpose, they proposed logit models, which they estimated using the Fama-MacBeth (1973) method.

Using data from US companies listed between 1963 and 1998, they concluded that more profitable companies (with a higher rate of return on total assets) with fewer investment opportunities (measured by the ratio of market value to the book value and the growth rate of assets) and larger companies, with the size of the company being measured by its share in market capitalisation, are characterised by a higher propensity to pay dividends. The work of Fama and French has inspired generations of researchers to study the factors determining the propensity to pay dividends.

Kowerski (2013) showed that the relationship between the propensity to pay dividends and investment opportunities has the shape of an inverted U – the propensity to pay dividends is low at very low and high investment opportunities, reaching the maximum for average value. DeAngelo et al. (2006) enriched the set of variables proposed by Fama and French with the maturity of the company measured by the ratios of retained earnings to total assets and to equity. Companies with higher values of these indicators (more mature) are more likely to pay dividends. The maturity of a company can also be determined by its age, measured by the number of years from the moment of its creation or the number of years it has been listed on the stock exchange (Salas and Chahyadi, 2006), as well as the square of its age (Al-Malkawi, 2008). Hedensted and Raaballe (2008) proposed a stock capital-to-equity ratio to measure the maturity of a company – more mature companies are characterized by a lower value of this ratio and thus a higher propensity to pay dividends. DeAngelo et al. (2006) also proposed the stickiness of dividends measured by a discrete variable, taking the value of 1 if the company paid a dividend in the previous year and a value of 0 otherwise.

Another factor determining the propensity to pay dividends that appears in many studies is the risk measured by the standard deviation of equity returns in the years preceding the payout decision (Hedensted and Raaballe, 2008), by the standard deviation of residuals from the market model which indicates specific risk (Li and Zhao, 2008), or a beta coefficient which indicates the systematic risk of a firm (Wang 2005). The higher the risk, the lower the probability of dividend payment. The company's propensity to pay dividends is also influenced by its capital structure as measured by the debt ratio (von Eije and Megginson, 2008). In most studies, the relationship is negative.

Allen et al. (2012) showed the impact of banks on companies' propensity to pay dividends. Having high-value loans, especially those with covenants, adversely affects the willingness of companies to pay dividends.

An important place in the analysis of the propensity to pay dividends is occupied by the ownership structure of the analysed companies, measured in many different ways, ranging from the identity of the controlling owner (domestic private large corporations, state-controlled firms, family-controlled firms, foreign private large corporations, etc.) to the value of the shares of the largest shareholder or second largest shareholder (Renneboog and Szilagyi, 2020). The results of the tests were not conclusive and depended on the market in which they were carried out, as well as on the period of the research. Quite often it has been shown that companies with a high concentration of shares in the hands of one shareholder are less willing to pay dividends, but it is also family companies that are reluctant to pay dividends (Gugler, 2003). The probability of a company paying dividends increases if the percentage of the shares held by managers is larger. Wei and Varela (2003) found that there is a positive link between government ownership and propensity to pay dividends.

The growing importance of share repurchase in recent years means that this variable has increasingly been used as an explanatory variable in dividend-paying propensity models. This is illustrated by the works of, among others, Von Eije and Megginson (2008), Jacob and Jacob (2013) and Kaźmierska-Jóźwiak (2019), who, however, treated decisions on both forms of payments independently. In other words, their models of the propensity to pay dividends and to purchase shares were built separately, without paying attention to the fact that the source of both forms of payments is the same net profit, which may cause the interdependence of both phenomena. Bhargava (2010, 635) drew attention to the need for the joint modelling of dividend payments and stock acquisitions and suggested that "share repurchase can be included as an explanatory variable in the model for dividends and, conversely, dividends would be included in the model for share repurchase, i.e., a system of two simultaneous equations would be appropriate." However, in his study he did not do so and independently estimated the company-specific random effects panel models for dividends and share repurchase. The system of two simultaneous equations was used by de Jong et al. (2003) for Canadian companies, as well as Kowerski and Kaźmierska-Jóźwiak (2022) for a balanced panel of 153 companies listed on the WSE in 2008-2016.

In addition to microeconomic factors, the propensity to pay dividends is also influenced by macroeconomic factors. Here, one must mention, first of all, the dividend premium developed by Baker and Wurgler (2004), which is the difference between the logarithms of weighted or unweighted average values of market value to the book value of assets ratios for dividend payers and for nonpayers. Baker and Wurgler's research and a number of other studies showed that a higher dividend premium results in the higher propensity to pay dividends; see for example Ferris et al. (2006) for the UK; De Rooij and Renneboog (2009) for the Netherlands. Ferris et al. (2009) showed that the dividend premium had a significant positive impact on dividend payment decisions only in countries with a common law system, and in Scandinavian countries. Nevertheless, the research of von Eije and Megginson (2008) did not confirm this theory in 15 countries of the 'old EU' between 1991 and 2005. Similarly, Denis and Osobov (2008) obtained inconclusive results in this regard. Jacob and Jacob (2013) examined 16,518 companies from 25 countries between 1990 and 2008 (66,282 observations). The countries covered by the study represented about 84% of the world's capitalisation in 2005. To describe the factors determining the propensity to pay dividends, in addition to the commonly used set of microeconomic variables, they used the annual growth rate of the gross domestic product in each country, the capitalisation at the end of the year to the value of gross domestic product ratio, and the quality index of the legal system, developed by Worldwide Governance Indicators – the higher the value of the index, the better the quality of the legal system in a given country. One parameter that turned out to be positive and statistically significant was the economic growth rate – the higher the GDP growth rate, the greater the probability of dividend payment. Surprising, however, was the negative value of the parameter at market capitalisation because it means that the smaller the capitalisation of the stock exchange in relation to the value of the gross domestic product, i.e. the lower the importance of the stock exchange, the greater the probability of dividend payment. This would mean that dividends are paid more often in developing markets, as these have smaller exchanges. Other studies did not confirm this.

Kowerski (2011), on the basis of estimated logit models, showed that the propensity to pay dividends by the companies listed on the WSE in the period 1996-2009 was also influenced by the economic sentiment of entrepreneurs and consumers during the time when the annual general meeting of shareholders made decisions on the distribution of profit, with the sentiment measured using the EU economic sentiment indicator.

The studies presented above treated decisions on dividend payment (logit or probit model) and decisions on the level of this payment (Lintner's model) separately. Few authors attempted to analyse both decisions together using the approach proposed by Heckman (1976), which consists in estimating a two-equation sample self-selection model. First, the participation equation (also called the selection equation) describes the process of selecting objects (in this case companies paying dividends); second, the outcome equation describes the formation of the studied phenomenon (in this case, the level of the dividend paid). This model solves the problem of sample bias resulting from self-selection. Kowerski (2012), using 2,263 observations, including 30.6% of the dividend-paying domestic companies listed on the WSE in 1996-2009, estimated Heckman's model of dividend yields. This was not Lintner's model and the dividend yields of the outcome equation were described using six explanatory variables. A similar approach to the analysis of the companies listed on two Vietnamese stock exchanges between 2006 and 2011 (2,131 nonfinancial observations) was used by Alphonse and Trung Tran (2014). The outcome equation described the dividend payout ratio explained by seven explanatory variables. In both papers, the participation equation was estimated using the ML method and the outcome equation with the OLS method. Kowerski and Bielak (2018), on the basis of data from

28 real estate companies listed on the WSE in the period 2006-2017 for at least two years, during periods when equity was positive, estimated the Heckman sample self-selection model, in which the outcome equation was the Lintner's model. Among the 162 observations, 50 dividend payments were recorded (with the share of payers at 30.86%). Despite the small number of observations, this pilot study showed that Heckman's model can be a very good tool for analysing dividend decisions not only because of its formal properties that ensure the consistency of the parameters estimator, but also because of its accurate description of the dividend decision-making process. For this reason, it is worth using it for much larger samples. The calculated target dividend payout ratio of the Polish real estate companies was 66.7%, and the calculated speed of adjustment (62.6%) indicated the relatively quick attainment of the target (Kowerski and Bielak 2018, pp. 109-110).

3. The problem of sample selection for the Lintner's model

The literature review shows that the assumption that only observations in which dividend payments have been recorded should be taken into account when estimating the Lintner's model is not always noted and taken into account in empirical research. Making this assumption is necessary for the proper testing of the hypothesis on smoothing dividends, i.e., a gradual adjustment of dividends to profits and, as a consequence, approaching the target payout ratio. Only some researchers are aware of this. Larkin et al. (2016, p. 5) explained it clearly when they wrote that "Firms that do not pay dividends have a constant dividend stream of zero, which mechanically assigns them to the top smoothing group. The behaviour of those firms is fundamentally different from the behaviour of firms that pay constant and positive dividends." In other words, if one wants to confirm Lintner's hypothesis on smoothing dividends, as many nonpayers as possible should be introduced into the sample, therefore the results of estimated Lintner's models based on observations from companies both paying and not paying dividends are over smoothing-biased. This has led many authors to conclude that Lintner's models should be estimated on the basis of data only from companies paying dividends continuously throughout the whole period adopted for the analysis.

However, there are at least two problems in this respect: the first problem is the small number of observations. Only a small proportion of companies pay dividends systematically in the long term. This problem affects to a much lesser extent the US market and research involving companies from many countries (e.g. the OECD, the EU and developing markets) where there are numerous companies at hand. For other studies, due to the low number of observations, researchers have to arbitrarily determine the length of payments that is only part of the analysed period. An example of this is the procedure used by Leary and Michaely (2011, p. 3212): "Our dataset starts with all firms in both the CRSP and Compustat databases for the period 1985-2005 (...) Removing non-dividend-paying firms reduces the number of sample firms from 13,872 to 3,877. Requiring at least 10 years between a firm's first and last dividends further reduces the number of sample firms to 1,574. These restrictions exclude many of the smaller firms. For our final estimation sample, we also require at least five years of non-missing values for all of the proxies for market frictions and control variables (....). After applying all of our screens, the final sample consists of 1,335 firms (9.6% of all firms) and 21,400 firm-year observations (an average of 16 years of data per firm)." In the research conducted by Mrzygłód et al. (2020) on companies from eight developing markets, the assumption of minimum six-year uninterrupted payouts reduced the starting list of 2,015 companies to 483 companies and the assumption about the completeness of financial data to 341 companies.

In the history of the WSE, only five companies (0.7% ever listed) paid dividends continuously for at least 20 years and 54 companies (8.0% ever listed) for at least 10 years.

The second problem seems to be more serious. Including in the Lintner's model only companies that continuously pay dividends (in accordance with the assumption of the model) means that the selected sample is not random. Leary and Michaely (2011, p. 3212) believed that if the purpose of the research is to form conclusions about dividend smoothing, such a choice of companies is acceptable. Yet in this situation, it is difficult to generalise the results to the entire market as they apply only to companies paying dividends – and yet dividend-paying companies are not the only market participants. Therefore, the question arises whether, when trying to determine the dividend policy of companies listed in a specific market and at a certain time, one should disregard information from companies that pay dividends irregularly or do not pay them at all? Does their behaviour not affect decisions about the level of payouts and the speed of adjustment to the target payout ratio of companies included in the Lintner's model that pay dividends continuously over a longer period of time? It seems that such an impact can take place. Therefore, how to reconcile the requirement resulting from the assumptions of the Lintner's model to estimate it only on the basis of observations concerning dividend payments with the need to take into account information from companies that pay dividends irregularly or do not pay them at all? The original proposal to solve this problem was presented later in the work.

4. Research hypothesis

The Lintner's model should be estimated only based on observations in which dividend payments were recorded. However, according to the author, the decisions of companies on the level of the dividends paid may be influenced by the number and characteristics of companies not paying dividends in the analysed market. If, for example, in a given year in a given market there is a low propensity to pay, this fact may be one of the factors in the reduction of the dividends offered by paying companies. In turn, a high propensity to pay may prompt the company to increase the paid dividend (catering theory).

Therefore, the following hypothesis was formulated:

The target dividend payout ratio and speed of adjustment calculated on the basis of the Lintner partial adjustment model are also influenced by the number and characteristics of companies that do not pay dividends.

The testing of the hypothesis requires an appropriate econometric tool. According to the author, the Heckman sample self-selection model is a tool that makes it possible to avoid a self-selection bias and to assess the significance of the impact of nonpayers on the estimated parameters of the Lintner's model.

5. Methodology of the study

5.1. Model specification

A sample selection to Lintner's model (only observations with dividend payments) is not random, hence the OLS/GLS estimators applied to Lintner's model are no longer consistent (Li and Prabhala, 2007). This is the so-called problem of sample self-selection, a solution to which was proposed by the winner of the Prize in Economic Sciences in Memory of Alfred Nobel, James J. Heckman. Heckman (1976) created a sample self-selection model consisting of two equations – the participation equation and the outcome equation. The first equation describes the process that a company follows in order to make a choice (make a decision to pay or not to pay a dividend). The second equation is, in a way, an essential equation, describing the studied phenomenon (the level of dividend payment). To appreciate the creator, over time, this model began to be called the heckit model.

The paper assumed that the participation equation is a probit panel model with random effects of the propensity to pay dividends:

$$Probit\ Y_{i,t} = \beta_0 + \beta_1 X_{1\ i,t-1(t)} + \beta_2 X_{2\ i,t-1(t)} + \cdots + \beta_k X_{k\ i,t-1(t)} + \mu_{1i,t}, \quad (4)$$

where $Y_{i,t} = 1$ when company *i* decided to pay dividend for year *t*, and 0 when company *i* decided not to pay dividend for year *t*; $X_{j\ i,t-1(t)}$ is the value of explanatory variable *j* for company *i* in year *t*–1 or in year t, depending on the nature of the variable; $\mu_{1i,t}$ is random disturbance of participation equation, which is the sum of random specific effects and white noise: $\mu_{1t} = \alpha_{i1} + \varepsilon_{1t}$.

The use of the model with fixed effects was not considered at all, as this would involve the removal from the panel observations of companies that never pay dividends and those that always pay dividends, which would significantly impoverish and perhaps even distort the results (Witkowski, 2012).

The estimated participation equation allows to calculate for each company in each year the fitted value of the probit $\left(Probit\ \hat{Y}_{it}\right)$ and the inverse of the Mills coefficient.

$$invMills_{it} = \frac{P(Probit\ \hat{Y}_{it})}{1-D(Probit\ \hat{Y}_{it})}, \quad (5)$$

where $P\left(Probit\ \hat{Y}_{it}\right)$ – probability density function for the fitted value of probit for company *i* in year *t*, $D\left(Probit\ \hat{Y}_{it}\right)$ – distribution function for the fitted value of probit for company *i* in year *t*.

The higher the fitted value of the probit, the higher the propensity to pay dividends, while the higher the inverse of the Mills coefficient, the lower the propensity to pay dividends.

The outcome equation is a dynamic panel Lintner's partial adjustment model supplemented with a third explanatory variable: the inverse values of Mills coefficients. In the article, it was proposed to check how in this role the variable: fitted values of probits calculated on the basis of the estimated participation equation, will 'behave'. Two measures of income were used in the outcome equation: net profit and cash flow:

$$DYRA_{i,t} = \alpha_0 + \alpha_1 DYRA_{\,i,t-1} + \alpha_2 ROA_{i,t}\left(or\ CFA_{i,t}\right) + \alpha_3 InvMills_{i,t}(or\ Probit\ \hat{Y}_{it}) + \mu_{2i,t}, \quad (6)$$

where $DYRA_{i,t}$ – the dividend yield ratio of company *i* for year *t*, expressed as the dividend paid by company *i* for year *t* to the average value of assets at the end of year *t*–1 and *t*.

Note the phrase "payment for year *t*", which means that, for example, for 2019, the dividend was paid in 2020, etc.; $DYRA_{\,i,t-1}$ – the dividend yield ratio of company *i* for year *t*–1, expressed as the dividend paid by company *i* for year *t*–1 to the average value of assets at the end of year *t*–2 and *t*–1; $ROA_{i,t}$ – return on assets: net profit achieved by company *i* in year *t* to the average of assets at the end of year *t*–1 and *t*; $CFA_{i,t}$ – return on cash-flow: cash-flow achieved by company *i* in year *t* to the average of assets at the end of year *t*–1 and *t*. Using the definition of Fama and Babiak (1968), it was assumed that cash-flow is the sum of net profit and depreciation; $Probit\hat{Y}_{it}$ – calculated on the basis of participation equation fitted values of probit variable *Y* for company *i* in year *t*; $InvMills_{i,t}$ – calculated on the basis of probit fitted values of the participation equation the inverse values of the Mills coefficient of company *i* in year *t.*

Only companies that paid dividends for a given year participated in the outcome equation.

The significant value of parameter α_3 indicates that the dividend yield ratio and, consequently, TDPR and SOA were significantly influenced by companies that did not pay dividends.

Heckman's self-selection model is a very good tool for analysing dividend decisions not only because of its formal properties that ensure the consistency of the parameters estimator, but also because of its accurate description of the two-step decision-making process. During the annual general meeting, the company first decides whether to pay a dividend and if the decision is positive, it determines the level of payment. Obviously, if a company does not make a decision to pay a dividend, the dividend level is zero.

5.2. Data

To illustrate the proposed method the calculations were carried out using data from companies listed on the WSE. For this purpose, an unbalanced panel was constructed, which included domestic companies, with the exception of banks, which at the end of 2019 were part of the WIG20, mWIG40 and sWIG80 indices and had been listed for at least three years, i.e. had entered the WSE no later than 31 December 2016. It was decided that the data would date back to 1998. Thus, for companies that entered the WSE before this year, data were collected starting from 1998. For companies that entered the WSE in 1998 or later, data were collected since their entry. The panel consisted of 112 companies, namely 80% of those included in the three basic WSE indices. The developed database was therefore an unbalanced panel of 1,509 observations and did not include observations with negative equity. The companies covered by the panel accounted for only 27.9% of all (401) domestic companies listed on the WSE at the end of 2019, but their share in the capitalisation of the domestic market amounted to 60.5% and their share in the book value of equity was 64.2%. Therefore, these companies were significantly larger than other companies listed on the WSE (Student's *t*-test).

The panel's imbalance rate was 38.8%. For the period 1998-2019, only nine companies did not pay dividends at all. Of the 1,509 observations, 824 were of companies paying dividends, which means that the propensity to pay dividends was 54.6% (Kowerski and Charkiewicz, 2021). The panel also included 50 companies (144 observations) that at least once paid dividends from retained earnings. It was a very heterogeneous group of companies, among which there were companies that supplemented their dividends from the last year's profit with retained earnings, but also companies that, despite the loss incurred in the last year, paid dividends from retained earnings. The motivations for the decision to use retained earnings for dividend payments were also very diverse (Kowerski, 2014). In the case of distributions from retained earnings, the traditional interpretation of the dividend payout ratio, as the quotient of dividend to net profit for the last fiscal year, also loses its meaning. In this case, it can take values greater than 100% or even negative. In Lintner's models estimated on the basis of observations from all dividend payers (including those paying not only from the profit for the last year), parameters α_3 turned out to be insignificant. Therefore, like Jeong (2013), Lintner's model was finally estimated, based on observations of paying dividends only from profit for the last fiscal year.

5.3. Selection of variables for the participation equation

The methods specific to the selection of variables for pooled or time series models cannot be used for the selection of variables for panel models (Kowerski and Bielak 2021). Therefore, for the selection of variables for the participation equation (a probit model of the propensity to pay dividends), a three-step procedure was proposed, taking into account the panel nature of the data:

1) using the ML method panel probit models with random effects of the propensity to pay dividends in regard to each potential explanatory variable separately are estimated. In the case of a quadratic dependency assumption, the model is estimated in regard to the potential variable and its square. Thus,
   1.1) it is checked whether the parameter at the explanatory variable is statistically significant at the level of 0.05,
   1.2) an LR test on intraclass correlation coefficient significance is performed. The adoption of the null hypothesis indicates that a model with random specific effects is appropriate,
   1.3) for the second step, those variables are assumed in which the parameters are significant and at the same time the LR test indicates that the model is appropriate.
2) A probit panel model with random effects of the propensity to pay dividends with all (not excluded in the first step) potential explanatory variables is estimated and the coincidence of the parameters is checked, i.e. the consistency of parameter signs on individual variables in the estimated model with parameter signs at the same variables in models with one variable estimated at the first step. Variables at which the parameters do not meet the principle of coincidence are excluded from further research. The principle of coincidence in a slightly different form was introduced into econometric literature by Professor Z. Hellwig (1976).
3) For variables that remain after two steps, the method of selection from general to specific is used (Charemza and Deadman, 1997). This method assumes that the model is first built taking into account all the remaining potential explanatory variables. Then, the variable with the highest value of the empirical significance level *p* (but greater than 0.05) is selected. This variable is removed and a new model is estimated in the subsequent step until all the values of the significance level *p* are less than 0.05.

The above procedure makes it possible to create an optimal set of explanatory variables. This procedure was applied to 32 potential explanatory variables describing both the economic and financial situation of the analysed companies and the Polish macroeconomic situation. In addition, on the basis of the analysis of previous research, and especially the Polish capital market (Kowerski, 2011; Kaźmierska-Jóźwiak, 2019; Kowerski and Kaźmierska-Jóźwiak, 2022), the so-called 'literature' set of nine variables was formulated.

5.4. Estimation of the Heckman's sample self-selection model of dividend payments

The estimation of the two-equation model of dividend payments by companies included in the unbalanced panel was made using the Stata 17.0 package. The procedure consists in estimating the probit panel model with random effects of dividend-paying propensity as participation equation and calculating the fitted values of the probit and *invMills* based on it, introduced as additional explanatory variables to the outcome equation, which is the Lintner's model.

Using the ML method (Witkowski, 2012, pp. 301-306), the parameters of two participation equations (optimal and literature) were estimated. The maximisation of the logarithm of the likelihood function is done using numerical methods of quadratic optimisation – in Stata it is the Gauss-Hermie algorithm although it is also possible to use other algorithms (Cameron and Trivedi, 2009, p. 611).

To assess the quality of the estimated participation equation, in addition to the level of the significance of individual parameters, the Wald test based on statistic $\chi^2(k)$ was applied, where k stands for the number of degrees of freedom equal to the number of explanatory variables in the model. The significance of statistic $\chi^2(k)$ means that together all the explanatory variables significantly impact on the dependent variable.

The intraclass correlation coefficient ρ, which is a quotient of intercept variance, and total variance, which is the sum of intercept variance and random disturbance term variance, was also calculated. In the absence of cross-object differentiation, the value will be close to 0 and a pooled model can be used. If the LR test shows that the coefficient is statistically significant, it means that a panel model with random effects was rightly used as individual companies are characterised by their own specific features (there is an inter-object differentiation).To assess the goodness of fit for the participation equation, count R^2 was used, which is a percentage quotient of the model's accurate indications to all observations (Gruszczyński, 2002, p. 84). However, due to the imbalance of the sample, it was assumed that $\hat{Y}_{i,t} = 1$ if the fitted probability of dividend payment calculated on the basis of the equation is greater than the share of payers in the total number of observations, i.e. from 0.546. An accurate indication of the model is the situation when $\hat{Y}_{i,t} = Y_{i,t}$ (Gruszczyński 2002, p. 80).

The outcome equation is a panel dynamic model estimated using a two-step GMM estimator (Arellano and Bond, 1991; Witkowski, 2012) while maximum lag of the dependent variable for use as instrumental was 2, and maximum lag of the predetermined variable for use as instrumental was 3. The outcome equations were estimated on the basis of observations regarding only payments from net profit (cash flow) for the last year. After abandoning the observations concerning payments made from the retained earnings and shortening the series due to the occurrence of the lagged dependent variable as the explanatory variable, the models were estimated on 536 observations.

Eight Lintner's models were estimated, in which the explanatory variables, in addition to the one-year lagged dividend, were:

- in two models, net profit and calculated on the basis of the optimal and literature participation equations, the values of the inverse of Mills coefficient,
- in two models, net profit and calculated on the basis of the optimal and literature participation equations, the values of the fitted probit,
- in two models, cash-flow and calculated on the basis of the optimal and literature participation equations, the values of the inverse of Mills coefficient,

- in two models cash-flow and calculated on the basis of the optimal and literature participation equations, the values of the fitted probit.

In order to compare the impact of the dividend policy of all the companies (i.e. payers and nonpayers) in the analysed market on the target dividend payment ratio and the speed of adjustment of paying companies, the classic Lintner's models without a third explanatory variable were also estimated. Comparisons were made based on calculated TDPR and the SOA ratios of pairs of models (with and without a third variable).

It should be noted that in models where income is measured using cash flow, the TDPR is the relation between dividend and cash flow, and since net profit can be at most equal to cash flow, the TDPR in such a model should be lower than in a model where income is measured by net profit.

6. Results

The procedure used to select variables for the participation equation made it possible to formulate an optimal model consisting of eight explanatory variables. The propensity to pay dividends was higher for larger (SIZE – logarithm of assets at 2019 prices at the end of year *t*) and more profitable companies (ROA – the value of net profit at year *t* to the average of assets at the end of year *t*–1 and *t*, in %), which is in line with the conclusions of Fama and French (2001). In contrast to the Fama and French model, investment opportunities (CE – capitalisation to the book value of the equity ratio at the end of year *t*) do not affect the willingness to pay dividends in a linear (negative) way, but take the shape of an inverted U. This means that the lowest propensity is characteristic of companies with the smallest and largest investment opportunities. Such a relationship for companies listed on the WSE was discovered in earlier studies (Kowerski, 2013; Kowerski and Kaźmierska-Jóźwiak, 2022). The propensity to pay dividends in year *t* is positively influenced by the tendency to pay in previous years (PROP_1 – the share of payments made to possible payments up to year *t*–1, in %), which confirms Lintner's thesis about the stickiness of dividends. On the other hand, the debt ratio (DR in %) and risk (RISK1 – the share price volatility coefficient calculated as the quotient of the difference between the maximum and minimum share price to the maximum price in year *t* in % and RISK2 – the share price volatility coefficient calculated as the quotient of the difference between the maximum share price in year *t* and its price at the end of year *t* to the maximum price in year *t*, in %) have a negative impact on the propensity to pay dividends. More indebted and risky companies are less willing to pay dividends.

Table 2. Results of the estimation of the participation equations

Variables	Optimal model		Literature model	
	Parameter	*p*-value	Parameter	*p*-value
Const.	-0.7938	0.034	-1.0140	0.006
SIZE	0.1687	0.001	0.1718	0.002
ROA (%)	0.0327	<0.001	0.0034	<0.001
CE	0.0975	0.011	0.0953	0.014
CE2	-0.0033	0.048	-0.0035	0.037
MAT (years)			0.0176	0.034
PROP_1 (%)	0.0129	<0.001	0.0119	<0.001
DR (%)	-0.0137	<0.001	-0.0152	<0.001
RISK1 (%)	-1.2017	<0.001		
RISK2 (%)	-1.1142	<0.001	-1.5263	<0.001
GDP (%)			-0.0621	0.039
ρ	0.3299		0.3557	
LR test: $\rho = 0$	55.99	<0.001	61.18	<0.001
Wald test	228.1	<0.001	220.92	<0.001
Count R^2 (%)	73.89		71.06	

Source: own calculations.

Table 3. Results of the estimation of outcome equations (Lintner's models)

Variables	Models in regard to ROA				Models in regard to CFA			
	Optimal		literature		optimal		literature	
	parameter	*p*-value	parameter	*p*-value	parameter	*p*-value	parameter	*p*-value
	model 1a		model 1b		model 2a		model 2b	
Const.	0.683	0.611	1.013	0.417	0.052	0.972	0.245	0.863
DYRA_1 (%)	0.351	0.003	0.357	0.003	0.357	0.003	0.364	0.003
ROA (%)	0.360	<0.001	0.350	<0.001				
CFA (%)					0.346	<0.001	0.339	<0.001
invMills	-1.277	0.257	-1.721	0.096	-1.804	0.102	-2.094	0.044
Wald test $\chi^2(3)$	146.77	<0.001	136.94	<0.001	121.62	<0.001	110.60	<0.001
AR(1) *z* statistic	-1.6673	0.0955	-1.6612	0.0967	-1.6504	0.0989	-1.6488	0.0992
AR(2) *z* statistic	-0.2680	0.7887	-0.2180	0.8274	-0.3250	0.7451	-0.2839	0.7765
Target dividend payout ratio TDPR (%)	55.60		54.47		53.84		53.37	
Difference with the TDPR of the model without self-selection (percentage points)	-3.24		-4.37		-4.56		-5.03	
Speed of adjustment SOA (%)	64.91		64.33		64.33		63.57	
Difference with the SOA of the model without self-selection (percentage points)	-0.82		-1.39		-0.59		-1.34	
	model 3a		model 3b		model 4a		model 4b	
Const.	-0.301	0.629	-0.323	0.596	-1.158	0.178	-1.196	0.148
DYRA_1 (%)	0.362	0.004	0.379	0.004	0.369	0.003	0.383	0.003
ROA (%)	0.302	0.001	0.289	0.003				
CFA (%)					0.291	0.001	0.282	0.002
$Probit\hat{Y}$	1.516	0.055	1.641	0.018	1.621	0.017	1.709	0.010
Wald test $\chi^2(3)$	80.01	<0.001	82.85	<0.001	77.50	<0.001	82.64	<0.001
AR(1) *z* statistic	-1.6799	0.0930	-1.6872	0.0916	-1.6745	0.0940	-1.6765	0.0936
AR(2) *z* statistic	-0.1864	0.8521	-0.0759	0.9395	-0.2564	0.7977	-0.1593	0.8734
Target dividend payout ratio TDPR (%)	47.44		46.43		46.16		45.74	
Difference with the TDPR of the model without self-selection (percentage points)	-11.41		-12.42		-12.24		-12.66	
Speed of adjustment SOA (%)	63.75		62.15		63.14		61.66	
Difference with the SOA of the model without self-selection (percentage points)	-1.97		-3.58		-1.77		-3.26	

Source: own calculations.

As is presented in table 2, the LR test showed that the intraclass correlation coefficient ρ is statistically significant, which means that a panel model with random effects was correctly used as individual companies have their own specific characteristics. The Wald test showed that, taken together, all explanatory variables significantly describe the dependent variable.

The literature model contains nine explanatory variables, in which, in addition to the variables from the optimal model, there are variables describing the maturity of the company (MAT – the time of company listing on the stock exchange at the end of year *t*, in years) and the situation in the Polish economy (GDP – annual growth rate in %). Moreover, the literature model turned out to be correctly estimated. It is characterised by only slightly worse goodness-of-fit to empirical data compared to the optimal model (count R^2 less by 2.83 percentage points).

In table 3, among the estimated Lintner's models in which the third variable was *invMills* it was only in the model where the income was described using cash flow and the *invMills* values came from the literature model of the propensity to pay (model 2b) that the parameter at the *invMills* variable was statistically significant. The Wald test indicated that, taken together, all the explanatory variables significantly describe the dependent variable. The Arellano-Bond test showed that in this model autocorrelations of the disturbances of the first and second order were statistically insignificant, which is consistent with the assumptions of the GMM method. The estimated model 2b shows that the greater the propensity to pay dividends (the lower value of *invMills*), the higher the dividend yield ratio. The TDPR calculated on the basis of model 2b, which is the relation of the dividend to cash flow, amounted to 53.37% and was 5.03 percentage points lower than the ratio calculated on the basis of a model that does not take into account the impact of the entire market, and thus companies that do not pay dividends. A similar direction of dependence also occurred with the speed of the adjustment ratio, which decreased by 1.34 percentage points. This means that nonpayers increase the smoothing of the process of reaching the target dividend payout ratio by paying companies. This confirms the formulated hypothesis, according to which the number and characteristics of companies that do not pay dividends have an impact on the value of the target dividend payout ratio and the speed of adjustment calculated on the basis of the Lintner's model.

The parameter signs in the other three models with the *invMills* variable (1a, 1b, 2a) were the same as in model 2b, but the insignificance of the parameter at *invMills* meant that the impact of the propensity to pay dividends was insignificant.

Higher quality was shown by models in which the third variable calculated from the participation equations was $Probit\hat{Y}_{it}$. In Lintner's models augmented by this variable, all the parameters, except constants, were statistically significant. The Wald test indicated that, taken together, all the explanatory variables significantly described the dependent variable. The Arellano-Bond test showed that in this model, autocorrelations of the disturbances of the first and second order were statistically insignificant, which is consistent with the assumptions of the GMM method. Cash flow is also a significant measure of income as net profit. Calculated on the basis of models 3a, 3b, 4a and 4b, the TDPRs ranged from 45.74% to 47.44% (lower in models with cash flow), and were more than 10 percentage points higher than the actual panel's dividend payout ratio for 1998-2019, which was 35.0%. The TDPRs were between 11.41 and 12.66 percentage points lower than the ratios calculated on the basis of the models not taking into account the impact of the entire market, and thus nonpayers, on the propensity to pay. It can be said that companies that do not pay dividends 'allow' paying companies to pay lower dividends. A similar direction of dependence also occurred for the speed of the adjustment ratio, which decreased from 1.77 percentage points to 3.26 percentage points.

The significance of parameter α_3 in the group of models with variable $Probit\hat{Y}_{it}$ indicates that the dividend yield ratio and, consequently, TDPR and SOA were significantly influenced by nonpayers, which even more strongly than in the case of models with *invMills* confirms the formulated hypothesis. The inclusion of the propensity to pay dividends in the entire market in Lintner's models reduces the speed of adjustment to the target payout ratio, so in accordance with Lintner's assumptions, dividends were gradually smoothed.

In all the estimated models, the constant term, as in the case of Fama and Babiak's studies (1968, p. 1136), turned out to be statistically insignificant. Therefore, Lintner's (1956, p. 107) thesis that a constant term (expected to be positive) reflects the greater reluctance to reduce than to raise dividends, was not confirmed.

It should also be noted that the estimated speed of adjustment ratios was higher than 60%, which is characteristic of emerging markets.

Based on this, it can be concluded that $Probit\hat{Y}_{it}$ is a better explanatory variable than *invMills,* although this variable due to its construction based, among others, on $Probit\hat{Y}_{it}$ must be strongly correlated with $Probit\hat{Y}_{it}$. In the presented study, the correlation coefficient between the two variables was -0.95 (p<0.001), but the advantage of the variable $Probit\hat{Y}_{it}$ also results from the 'good' interpretative properties: the higher the value of $Probit\hat{Y}_{it}$, the greater the probability of paying a dividend, the higher the value of which affects the higher dividend yield. *InvMills* has no economic interpretation.

Confirming the formulated hypothesis means that the Heckman sample self-selection model was the right tool for estimating Lintner's model.

7. Conclusions

One of the most important (though not mandatory) financial documents adopted by management boards (less often by general meetings of shareholders) and published by the company, is its dividend policy. In Poland, the publication of the dividend policy also results from principle 4.14 of Best Practice for GPW … (2021).

The dividend policy defines the future (usually in the medium term – up to five years) frequency and level of dividend payouts, expressed by means of the future dividend payout ratio. The management board determines the future dividend payout ratio primarily on the basis of forecasts of its own financial situation, but should also take into account forecasts for the entire market and sector in which the company operates. For such forecasts, the target dividend payout ratio based on the Lintner's model for the entire market and sector can be very useful. Naturally, the better the Lintner's model estimates, the greater the practical usefulness of model. As shown in this paper, no effective methods of estimating the Lintner's model that meet its assumptions and ensure obtaining unbiased parameters have been developed so far.

According to the author, this can be ensured by the use of Hackman's self-selection model, which could be a very good tool for forecasting target dividend payout ratio and speed of adjustment, not only because of its formal properties ensuring the consistency of the parameters' estimator, but also because of its accurate description of the decision process, which is of a two-step nature (decisions on payment or nonpayment, and if the decision is positive, determining the payout level).

The results of the estimation of Heckman's sample self-selection models confirm that the decisions of companies listed on the WSE not to pay dividends affect the target dividend payout ratio and speed of adjustment estimated on the basis of data from companies paying dividends, using the Lintner's model. The inclusion of information on the propensity to pay dividends in Lintner's model resulted in a decrease of the target payout ratio and speed of adjustment.

The sample self-selection model does not require making many observations, as is usually done by accepting into the partial adjustment model only companies that have been making payments continuously for a long time. This allows to correctly estimate the Lintner's models for small markets with a small number of companies paying dividends continuously over a longer period of time (e.g. the WSE).

The proposed model can be used for sectoral as well as subperiods analyses, for example: before – after global financial crisis, high – low interest rate level, or the same tax rates for dividend income and capital gains – different tax rates for dividend income and capital gains.

References

Ahmed, H., & Javid, A.Y. (2009). Dynamics and determinants of dividend policy in Pakistan (evidence from Karachi Stock Exchange non-financial listed firms). *International Research Journal of Finance and Economics*, 25(3), 148–171.

Aivazian, V., Booth, L., & Cleary, S. (2003). Dividend policy and the organization of capital markets. *Journal of Multinational Financial Management*, 13(2), 101–121. https://doi.org/10.1016/S1042-444X(02)00038-5

Allen, F., Bernardo, A., & Welch, I. (2000). A theory of dividends based on tax clienteles. *The Journal of Finance*, 55(6), 2499–2536. https://doi.org/10.1111/0022-1082.00298

Allen, L., Gottesman, A., Saunders, A., & Tang, Y. (2012). The role of banks in dividend policy. *Financial Management*, 41(3), 591–613. https://doi.org/10.1111/j.1755-053X.2012.01207.x

Al-Malkawi, H. A. N. (2008). Factors influencing corporate dividend decision: evidence from Jordanian panel data. *International Journal of Business*, 13(2), 177–195.

Al-Najjar, B., & Belghitar, Y. (2012). The information content of cashflows in the context of dividend smoothing. *Economic Issues*, 17(2), 57–70.

Alphonse, P., & Trung Tran, Q. (2014). A two-step approach to investigate dividend policy: Evidence from Vietnamese stock market. *International Journal of Economics and Finance*, 6(3), 16–28. http://dx.doi.org/10.5539/ijef.v6n3p16

Alzahrani, M., & Lasfer, M. (2009). *The impact of taxation on dividends: A cross-country analysis*. Available at SSRN: https://ssrn.com/abstract=1343826. http://dx.doi.org/10.2139/ssrn.1343826

Andres, C., Betzer, A., Goergen, M., & Renneboog, L. (2009). Dividend policy of German firms: A panel data analysis of partial adjustment models. *Journal of Empirical Finance*, 16(2), 75–187. https://doi.org/10.1016/j.jempfin.2008.08.002

Andres, Ch., Doumet, M., Fernau, E., & Theissen, E. (2015). The Lintner model revisited: Dividends versus total payouts. *Journal of Banking & Finance*, 55, 56–69. https://doi.org/10.1016/j.jbankfin.2015.01.005

Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *Review of Economic Studies*, 58(2), 277–297. https://doi.org/10.2307/2297968

Asimakopoulos, A., Asimakopoulos, S., & Zhang, A. (2021). Dividend smoothing and credit rating changes. *The European Journal of Finance*, 27(1–2), 62–85. https://doi.org/10.1080/1351847X.2020.1739101

Baker, M., & Wurgler, J. (2004). A catering theory of dividends. *The Journal of Finance*, 59(3), 1125–1165. https://doi.org/10.1111/j.1540-6261.2004.00658.x

Balli, F., Agyemang, A., Gregory-Allen, R., & Balli, H. O. (2022). Corporate dividend smoothing: The role of cross-listing. *Journal of Corporate Finance*, 72, 102–151. https://doi.org/10.1016/j.jcorpfin.2021.102151

Best practice for GPW listed companies 2021 (2021). GPW https://www.gpw.pl/pub/GPW/files/PDF/dobre_praktyki/en/DPSN2021_EN.pdf

Bhargava, A. (2010). An econometric analysis of dividends and share repurchases by US firms. *Journal of the Royal Statistical Society*, Series A, 173(3), 631–656. https://doi.org/10.1111/j.1467-985X.2010.00644.x

Bremberger, F., Cambini, C., Gugler, K., & Rondi, L. (2016). Dividend policy in regulated network industries: Evidence from the EU. *Economic Inquiry*, 54(1), 408–432. https://doi.org/10.1111/ecin.12238

Cameron, A. C., & Trivedi, P. K. (2009). *Microeconometrics using Stata.* A Stata Press Publication.

Charemza, W., & Deadman, D. F. (1997). *Nowa ekonometria*. PWE.

Chemmanur, T. J., He, J., Liu, G., & Liu, Y. H. (2010). Is dividend smoothing universal? New insights from a comparative study of dividend policies in Hong Kong and the U.S. *Journal of Corporate Finance*, 16(4), 413–430. https://doi.org/10.1016/j.jcorpfin.2010.03.001

DeAngelo, H., DeAngelo, L., & Stulz, R. (2006). Dividend Policy and the Earned/Contributed Capital Mix: A Test of the Life-cycle Theory. *Journal of Financial Economics*, 81(2), 227–254. https://doi.org/10.1016/j.jfineco.2005.07.005

Denis, D., & Osobov, I. (2008). Why do firms pay dividends? International evidence on the determinants of dividend policy. *Journal of Financial Economics*, 89(1), 62–82. https://doi.org/10.1016/j.jfineco.2007.06.006

von Eije, H., & Megginson, W. (2008). Dividends and Share Repurchases in the European Union. *Journal of Financial Economics*, 89(2), 347–374. https://doi.org/10.1016/j.jfineco.2007.11.002

Fama, E. F., & Babiak, H. (1968). Dividend policy: An empirical analysis. *Journal of the American Statistical Association*, 63(324), 1132–1161.

Fama, E. F., & French, K. F. (2001). Disappearing dividends: Changing firm characteristics or lower propensity to pay? *Journal of Financial Economics*, 60(1), 3–43. https://doi.org/10.1016/S0304-405X(01)00038-1

Fama, E. F., & French, K. F. (2002). Testing trade-off and pecking order predictions about dividends and debt. *The Review of Financial Studies*, 15(1), 1–33. https://doi.org/10.1093/rfs/15.1.1

Fama, E. F., & MacBeth, J. D. (1973). Risk, return and equilibrium: empirical tests. *Journal of Political Economy*, 81(3), 607–636. https://doi.org/10.1086/260061

Fernau, E., & Hirsch, S. (2019). What drives dividend smoothing? A meta regression analysis of the Lintner model. *International Review of Financial Analysis*, (61), 255–273.

Ferris, S. P., Jayaraman, N., & Sabherwal, S. (2009). Catering effects in corporate dividend policy: The international evidence. *Journal of Banking and Finance*, 33(9), 1730–1738. https://doi.org/10.1016/j.jbankfin.2009.04.005

Ferris, S. P., Sen, N., & Yui, H. P. (2006). God save the queen and her dividends: Corporate payouts in the United Kingdom. *Journal of Business*, 79(3), 1149–1173. https://www.jstor.org/stable/10.1086/500672

Grullon, G., & Michaely, R. (2002). Dividends, share repurchases, and the substitution hypothesis. *The Journal of Finance*, 57(4), 1649–1684. https://doi.org/10.1111/1540-6261.00474

Gruszczyński, M. (2002). *Modele i prognozy zmiennych jakościowych w finansach i bankowości*. Oficyna Wydawnicza Szkoły Głównej Handlowej.

Gugler, K., & Yurtoglu, B. B. (2003). Corporate governance and dividend payout policy in Germany. *European Economic Review*, 47(4), 731–758. https://doi.org/10.1016/S0014-2921(02)00291-X

Gupta, S., Dogra, B., & Vashist, A. A. (2011). A study on validity of Lintner's model of dividend in Indian companies. *International Journal of Financial Management*, 1(4), 63–70.

Heckman, J. J. (1976). The common structure of statistical models of truncation, sample selection and limited dependent variables and a simple estimator for such models. *Annales of Economic and Social Measurement*, 5(4), 475–492.

Hedensted, J. S., & Raaballe, J. (2008). *Dividend determinants in Denmark*. Working Paper, University of Aarhus, http://ssrn.com/abstract=1123436. http://dx.doi.org/10.2139/ssrn.1123436

Hellwig, Z. (1976). *Przechodniość relacji skorelowania zmiennych losowych i płynące stąd wnioski ekonometryczne*. Przegląd Statystyczny, 23(1), 3–20.

Jacob, M., Jacob,M. (2013). Taxation, dividends, and share repurchases: Taking evidence global. *Journal of Financial and Quantitative Analysis*, 48(4), 1241–1269. https://doi.org/10.1017/S0022109013000367

Javakhadze, D., Ferris, S., & Sen, N. (2014). An international analysis of dividend smoothing. *Journal of Corporate Finance*, 29, 200–220. https://doi.org/10.1016/j.jcorpfin.2014.09.007

de Jeong, J. (2013). Determinants of dividend smoothing in emerging markets: The case of Korea. *Emerging Markets Review*, 17, 76–88. https://doi.org/10.1016/j.ememar.2013.08.007

Kaźmierska–Jóźwiak, B. (2019). *Polityka wypłat na rzecz akcjonariuszy. Determinanty–relacja rynku–oceny*. Wydawnictwo Uniwersytetu Łódzkiego.

Kowerski, M. (2011). *Ekonomiczne uwarunkowania decyzji o wypłatach dywidend przez spółki publiczne*. Konsorcjum Akademickie.

Kowerski, M. (2012). Modele selekcji próby stóp dywidend spółek notowanych na Giełdzie Papierów Wartościowych w Warszawie*. Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu*, 254, 113–123.

Kowerski, M. (2013). Możliwości inwestycyjne a skłonność do płacenia dywidend. *Bank i Kredyt*, 44(6), 623–646.

Kowerski, M. (2014). Uwagi dotyczące sposobu liczenia stopy wypłaty dywidendy. *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu*, 371, 188–212. https://doi.org/10.15611/pn.2014.371.16

Kowerski, M., & Bielak, J. (2018). Self-selection models in determination of target dividend payout ratio of real estate domestic companies quoted on the Warsaw Stock Exchange*. Barometr Regionalny. Analizy i Prognozy*, 16(1), 99–112. https://doi.org/10.56583/br.390

Kowerski, M., & Bielak, J. (2021). Kilka uwag na temat pomiaru zależności pomiędzy zmiennymi o panelowej strukturze danych. *Wiadomości Statystyczne. The Polish Statistician*, 66(5), 7–25. https://doi.org/10.5604/01.3001.0014.8781

Kowerski, M., & Kaźmierska-Jóźwiak, B. (2022). The proposal of corporate payout modelling. *Inzinerine Ekonomika-Engineering Economics*, 33(1), 59–72. https://doi.org/10.5755/j01.ee.33.1.28496

Kowerski, M., & Wypych, M. (2016). Ownership structure and dividend strategy of public companies. Evidence from Poland. *Barometr Regionalny. Analizy i Prognozy*, 14(4), 179–192. https://doi.org/10.56583/br.479

Larkin, Y., Leary, M. T., & Michaely, R. (2016). Do Investors Value Dividend Smoothing Stocks Differently? *Management Science* 63(12), 4114-4136. https://doi.org/10.1287/mnsc.2016.2551

Leary, M. T., & Michaely, R. (2011). Determinants of dividends smoothing: empirical evidence. *The Review of Financial Studies*, 24(10), 3197–3249. https://doi.org/10.1093/rfs/hhr072

Li, K., L., & Prabhala, N. R. (2007). *Self-selection models in corporate finance*. In B.E. Eckbo (ed.) *Handbook of Corporate Finance. Empirical Corporate Finance*, 37–86. Elsevier/North-Holland.

Li, K., & Zhao, X. (2008). Asymmetric information and dividend policy. *Financial Management*, 37(4), 673–694. https://doi.org/10.1111/j.1755-053X.2008.00030.x

Lintner, J. (1956). Distribution of incomes of corporations among dividends, retained earnings and taxes. *American Economic Review*, 46(2), 97–113.

Majumdar, A. (2016). Validity of Lintner's model in Indian FMCG sector: An empirical analysis. *Indian Journal of Applied Research*, 6(10), 180–182.

Mrzygłód, U., Nowak, S., Misionek-Schweda, M., & Kwiatkowski, J. (2020). *Wygładzanie dywidend na wschodzących rynkach akcji*. Wydawnictwo Uniwersytetu Gdańskiego.

Nakamura, M. (1989). Asymmetry in the dividend behaviour of US and Japanese firms. *Managerial and Decision Economics*, 10(4), 261–274. https://doi.org/10.1002/mde.4090100403

Renneboog, L., & Szilagyi, P. (2020). How relevant is dividend policy under low shareholder protection? *Journal of International Financial Markets Institutions and Money*, 64, 1–18. https://doi.org/10.1016/j.intfin.2015.01.006

Salas, J. M., & Chahyadi, C. S. (2006). *Is there a lower propensity to pay dividends? A decomposition of dividend payers*. http://ssrn.com/abstract=635781. http://dx.doi.org/10.2139/ssrn.635781

Shinozaki, S., & Uchida, K. (2014). Ownership structure, tax regime, and dividend smoothing: International evidence. *Asian Finance Association, Annual Meeting Paper*, available at SSRN: https://ssrn.com/abstract=2139897. http://dx.doi.org/10.2139/ssrn.2139897

Skinner, D. J. (2008). The evolving relation between earnings, dividends, and stock repurchases. *Journal of Financial Economics*, 87(3), 582–609. https://doi.org/10.1016/j.jfineco.2007.05.003

Sura, J., S., Pal, K., & Bodla, B. S. (2006). Factors influencing dividend policy decisions in banking sector: An Indian evidence. *Amity Business Review*, 7(2), 64–76.

Wang, Y. (2005). *The effect of dividend initiations on stock returns: A propensity score matching approach*, http://homes.chass.utoronto.ca/~yanwang/dividend.pdf

Wei, Z., & Varela, O. (2003). State equity ownership and firm market performance: Evidence from China's newly privatized firms. Global Finance Journal, 14(1), 65-82. https://doi.org/10.1016/S1044-0283(03)00005-X

Witkowski B. (2012). *Modele danych panelowych*, In M. Gruszczyński (ed.), *Mikroekonometria. Modele i metody analizy danych indywidualnych*. Oficyna a Wolters Kluwer business, 267-308.

Received: December 2022, revised: August 2023