Article

Modeling and Management of Power Supply Enterprises' Cash Flows

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Abstract: The purpose of the study is to assess the efficiency of cash flow management at power supply companies of the CIS (Commonwealth of Independent States) countries. A methodological approach to cash flow forecasting with the use of linear and polynomial regression has been developed. The study is based on the data provided by 12 power supply companies operating in CIS member countries. Forecasting based on the generated polynomial models of multiple regression of cash flow for the power supply companies under study confirms the strong possibility of extrapolating the studied trends to future periods. Compared to the linear model, the polynomial one confirms higher values of the determination coefficients for the majority of power supply companies. The projected volumes of cash inflow, cash outflow, and net cash flows of power supply companies with the application of the described polynomial multiple regression models have a fairly high degree of approximation. The correlations between operating cash flows and outflows, between total cash inflow and outflow of the majority of power supply companies are high. The low level of synchronization between cash inflows and outflows of the companies under study is associated with the specifics of their financial and investment activities and the cash flow management policy. It has been proven that energy enterprises' financial stability significantly depends on the synchronization and uniformity of cash flows. The proposed methodological approach allows identifying enterprises by the criterion of riskiness from the standpoint of the synchronization and homogeneity of their cash flows.

Keywords: forecasting; linear regression; planning; polynomial regression; power supply

1. Introduction

Currently, power supply companies are an integral component of the energy system. Economic stability as well as national and international energy security depend on the reliability of their operation. The transition to new systems of incentive tariff setting, the implementation of which affects the size and structure of cash flows of power supply companies in different countries and regions, requires a proper theoretical and methodological justification [1–6].

The efficiency of enterprise cash flow management determines their ability to achieve current financial goals as well as ensure solvency, financial stability, and balance in the long term [7]. In the context of the highly dynamic internal and external environment of enterprises, a decrease in their solvency and financial stability is an urgent problem of

imbalance and unevenness of cash flows. The economic and legal consequence of this is the insolvency and bankruptcy of a significant number of power supply enterprises [8]. These problems in a large number of enterprises indicate that they do not have an effective cash flow planning system. The management of enterprises gives little attention to cash flow management both at the operational and strategic levels. Cash flow planning is a practical tool that allows companies to ensure the synchronization of cash flows [9].

According to the modern scientific paradigm of corporate finance, cash flows are one of the key factors in the formation of enterprise value. The greater volume of cash flows generated by the assets of the enterprise contributes to its greater market value. Maximization of the market value of enterprises and the welfare of shareholders is a strategic goal of the enterprise financial management [10]. In this regard, the study is aimed at the improvement of practical tools for planning and managing cash flows to ensure a high level of solvency, achieve financial balance, and increase the market value of power supply companies in the short and long term.

2. Literature Review

The issue of determining the economic nature of cash flows is extremely important in the theoretical and practical aspect, as the existing approaches to the interpretation of the essence of cash flows will further determine the foundations of their planning and control. In addition, the issue of determining the place and role of cash flows in corporate finance management in order to improve the current system of financial management of enterprises is still relevant [11]. As evidenced by financial theory and practice, there is no unified approach for determining the economic essence of the definition of enterprise cash flow, as there is a controversy among scientists and practitioners over this issue [12].

Any financial transaction can be associated with a certain cash flow, that is, a set of payments (outflows) and receipts (inflows) of funds distributed over time and arising from managerial decisions within operating, investing, and financial activities [13]. Semantically, cash flow is a quantitative expression of the money that an enterprise has at a particular point of time. From the perspective of an investor, this is the expected return on investment. From the point of view of business leaders, cash flow is a projection of cash flow, etc. In either case, the dynamics of the company cash flow is a continuous process [14]. However, this approach to understanding the essence of cash flows is too fragmentary and does not allow reflecting all aspects of this phenomenon.

The amount of money that an enterprise needs depends on the degree of predictability of both revenue receipts from economic activities and payments (demand) to suppliers and employees. Cash flow is the receipt of funds that allows the company to meet the demand for them [15]. An alternative to this is the availability of external investors who are willing to finance any cash deficit. However, in order to attract external investment, an enterprise has to confirm its ability to achieve a positive cash flow that will allow it to pay interest and ultimately pay the investors back [16]. There are three approaches to the essence of enterprise cash flows: static, dynamic, and aggregated. Each of these approaches discloses the essence of cash flows taking into account their specific characteristics. The advocates of the static approach define cash flow as the net cash flow in a given period of time, while at the dynamic level, cash flow is the movement of funds [17].

Cash flow planning, on the one hand, is the process of developing a system of projects and targets for the development of various types of these flows for the operating, investing, and financial activities of an enterprise in the next period. On the other hand, it is a set of measures and tools for forecasting and managing the cash flow cycle, which consists of two parts: projected cash inflows and outflows [18]. Cash flow planning can be viewed as the process of developing cash flow plans for various activities with the help of specific means and tools. It involves the creation of a system of projected financial performance indicators, on the basis of which cash flow plans are drawn up and deviations from the desired values are monitored (estimated, identified, and corrected) [19]. The cash flow planning system of enterprises consists of three levels: strategic (long-term) planning; current (tactical)

planning; and operational planning. The system of strategic cash flow planning is designed to develop and forecast the most important targets for the development of cash flows. Tactical cash flow planning aims to ensure that negative and positive cash flows are balanced and synchronized throughout the year. Tactical planning of enterprise cash flows involves two major documents related to the income and expenditure budget, and the cash flow budget. Based on the cash flow budget, it is possible to determine the projected cash inflow and outflow of the company; it allows the assessment of the structure of settlements with suppliers and buyers within a given period [20].

The initial aspect of the formation of a cash flow management model for a power supply enterprise is the definition of its strategic goal [21]. Based on the principles of building a cash flow management system, this goal should be subordinated, on the one hand, to the implementation of the main goal of financial management (meeting stakeholders' interests) [22,23], and on the other hand, to ensure the implementation of an enterprise's general development strategy [24]. When forming a strategy for managing cash flows of a power supply enterprise, conceptual aspects are determined, the implementation of which implies the achievement and implementation of the strategic goal of managing its cash flows [25]. The power supply enterprise's cash flow management strategy defines the main priorities that must be implemented in the process of managing its cash flows [26,27]. Key criteria for the effectiveness of cash flow management are identified. They are divided into components and are communicated to the employees of an enterprise who are responsible for them [28].

For the effective functioning of the cash flow management system of a power supply enterprise, making optimal management decisions, it is necessary to establish stably functioning information channels that will provide company's management with timely, reliable, and necessary information [29,30]. It should be noted that these should be both internal and external information channels, which are formed as a result of monitoring the environment of an enterprise [31–33].

Compliance with the time frames and volumes of payments on loans is an important component of control of outgoing cash flows of a power supply company [34,35]. If borrowed capital is attracted by issuing bonds, then the cash flow generated by this financial transaction is clearly determined in the bond issue prospectus. At the same time, it defines the time of coupon payments and the terms of bond redemption. The payment schedule on bonds is the basis for planning this type of initial cash flow [36]. At the same time, it also acts as a tool for controlling the initial cash flow from the financial activities of a power supply company. Compliance with it is an important component of ensuring the solvency of a power supply company [37,38]. An important factor that will influence the cash flows of power supply companies is the introduction of incentive tariff regulation [39,40].

To effectively control the intended use of investment funds, a power supply company can use current accounts with a special mode of use [41]. The accumulated investment resources have a designated purpose and can be used to finance the activities of the required investment program [42,43]. Power supply companies can use financial ratios based on cash flows as planning and cash flow control tools [44]. In particular, the planned values of the coefficients of cash flows can act as target indicators in the planning of cash flows [45]. At the same time, they can also be tools for controlling cash flows in the process of comparing actual values with planned ones [46]. To balance the cash flows of a power supply company in the long run, it is important to predict the occurrence of a cash gap, which manifests itself in the inability to fulfill the company's obligations at a certain point in time due to the lack of funds in the account [47]. The most common way to cover cash gaps is a short-term loan [48,49].

To ensure the proper and timely synchronization of cash flows, it is necessary to create an effective system of financial planning and forecasting of cash flows that involves cash balance assessment at the beginning of the period, maintenance of the balance of cash inflows and outflows over the current period, calculation of the deficit (or excess) cash flow and the possibility of its balancing, and support for the creation of a cash reserve for

making payments at the end of the period [50]. The alignment of cash flows is aimed at smoothing their volumes in the context of individual intervals of the time period under consideration. The use of this assessment method makes it possible to eliminate the impact of seasonal and cyclical fluctuations on the cash flow creation, optimize the average cash balance, and increase liquidity indicators [51,52].

However, from the perspective of the applied challenges of our time, the issues of theoretical and methodological substantiation of enterprise cash flow planning and management are still found in the scientific and practical literature. The present paper aims to eliminate this gap in science by improving methodological tools for modeling and managing the cash flows of power supply companies. The purpose of the research is to assess the effectiveness of cash flow management of power supply companies in the CIS (Commonwealth of Independent States) countries in the context of planning and control by projecting their long-term values. To achieve this goal, the following research tasks have been set:

- To deepen the conceptual foundations of planning and control of the cash flow of enterprises;
- To reveal the methodological basis for cash flow planning and control;
- To analyze cash flows from operating, investing, and financial activities of power supply companies;
- To identify the analytical possibilities of using financial ratios to assess the cash flows of enterprises; and
- To develop an econometric model of balancing the cash flows of power supply companies and to forecast them.

At the same time, the study formulated the following mutually exclusive hypotheses:

Hypotheses 0 (H0). *The level of synchronization of cash flows does not depend on the level of financial stability and balance of power supply companies;*

Hypotheses 1 (H1). *The level of financial stability and equilibrium of power supply enterprises largely depends on the level of synchronization and uniformity of cash flows.*

3. Materials and Methods

In order to effectively analyze the cash flow from the operating activities of power supply companies, the study takes into account the fact that cash flow planning and forecasting processes should also be considered. Therefore, in the conceptual model of cash flow planning, it is assumed that it is feasible to start the process of planning cash flows from operating activities along with the development of a long-term forecast of operating cash flow for the period of 5 years: up to 2025. In order to make a long-term forecast on operating cash flow, the capabilities of Microsoft Excel were used. Operating cash flow forecasting differs from planning—it is a guideline of probabilistic nature. The Microsoft Excel "Forecast" function made it possible to predict the values of operating cash inflows and outflows of power supply companies for the next 5 years with the help of a linear approximation based on the data on their actual volumes for the period of 2015–2019. The projected values of the volume of cash flow from operating activities of power supply companies calculated in the study can be used as long-term indicators in the process of cash flow planning.

The planned volume of net cash flow from operating activities ($OCF_{net(p)}$) is determined by the formula:

$$OCF_{net(p)} = OCF_{in(p)} - OCF_{out(p)}, \tag{1}$$

where $OCF_{in(p)}$ is the planned volume of operating cash inflow; $OCF_{out(p)}$ is the planned volume of operating cash outflow.

The planned volume of cash inflow from operating activities is determined by the formula:

$$OCF_{in(p)} = EE_p + AE_p + I_p + D_p + TF_p + TE_p + OE_p, \tag{2}$$

where EE_p is projected revenue from electricity supplies; AE_p is projected revenue from advance payments; I_p is the planned volume of cash inflow from bank interest; D_p is the planned volume of cash inflow from debtors; TF_p is the planned amount of cash inflow from target financing; TE_p is the projected tax and obligatory payment refund; OE_p is the planned volume of other cash inflows from operating activities.

The planned volume of cash outflow from operating activities is determined by the formula:

$$OCF_{out(p)} = EP_p + AP_p + S_p + TP_p + OP_p, \tag{3}$$

where EP_p is projected payments for the purchase of electricity; AP_p is the planned volume of advance payments by the power supply company; S_p is the planned volume of employee payments; TP_p is the planned amount of tax, fee, and other mandatory payments; OP_p is the planned amount of other payments for operating activities.

The planned cash inflow from electricity supplies is determined as follows:

$$EE_p = \sum_{i=1}^{n} Q_i \times t_{i(plan)} \times K_{i(plan)} \tag{4}$$

where Q_i is the planned volume of supply to the ith consumer of electricity; $t_{i(plan)}$ is the average electricity rate for the ith consumer in the planning period; and $K_{i(plan)}$ is the planned payment ratio of the ith consumer. The planned payments for the purchase of electricity are determined as follows:

$$EE_p = Q_p \times t_{p(plan)} \times K_{p(plan)} \tag{5}$$

where Q_p is the total volume of electricity purchase in the planning period; $t_{p(plan)}$ is the planned weighted average electricity price in the planning period; and $K_{p(plan)}$ is the planned payment coefficient.

The proposed methodology for determining the planned volume of net cash flow from operating activities of power supply companies ($OCF_{net(p)}$) takes into account the impact of key factors that determine operating cash flows. The planned volumes of advance payments determine the cash flows that will come from consumers in the planning period to pay for future electricity supplies. They are determined on the basis of contractual conditions between the supplier and the consumer of electricity. To plan cash flows from operating activities of power supply companies, it is necessary to determine the volumes of advance payments in the planning period. The planned volume of cash inflows from debtors is determined on the basis of the analysis of the claims work with debtors to make them pay off penalties for the late electricity bill payment. The planned volume of cash inflow from the current account interest rate is determined based on the balance of available funds and the interest rate. The planned volume of income from target financing is determined on the basis of the analysis of state programs providing for the provision of preferences to certain groups of electricity consumers.

In addition to the volume of supplies (purchase) of electricity and the weighted average electricity supply (purchase) price, the methodology for planning cash flows from operating activities includes payment ratios for each individual electricity consumer (K_i) and the power supply company itself. On the one hand, they reflect the level of settlement discipline of electricity consumers (and the power supply company itself), and on the other hand, they determine the real volumes of cash inflows and outflows in the process of operating activities of power supply companies. We assume that the coefficients of consumer and power supply company payments can be effective tools for the efficient management of cash flows from the operating activities of power supply companies. We propose to calculate the coefficient of electricity consumer payments (K_i) as the ratio of the amount of money that has been paid (in case of the actual payment coefficient) or will

be paid (in case of the planned payment coefficient) for the electricity consumed to the cost of the electricity supply. It is calculated as follows:

$$K_i = \frac{OCF_{in(i)}}{E_i},$$ (6)

where $OCF_{in(i)}$ is the amount of money that has been received (or will be received) from the ith consumer; and E_i is the cost of electricity supplied to the *i*th consumer. From the perspective of cash inflow, the most favorable value of this coefficient is >1. It describes a situation when the consumer has no debt for the consumed electricity, but there are advance payments for future electricity supplies. In the context of the confidentiality of information on the settlements of individual consumers on the basis of the data found in the financial statements of power supply companies, a consolidated modification of the consumer payment coefficient is proposed. It can be defined as the ratio of cash inflows from the sales of products (goods, services), from buyers and customers, to the cash inflow from the sales of products over the period under study.

The starting point of the operating cash inflow management $\left(OCF_{in(i)}\right)$ of power supply companies is the calculation of the actual value of the coefficient $K_{i(fact)}$. Monitoring of the actual value of the payment coefficient of the ith consumer is based on the value of the coefficient of payments $K_{i(fact)} \geq 1$, as well as the actual value of the coefficient of payments of the *i*th consumer along with the planned one $K_{i(fact)} \geq K_{i(plan)}$. Furthermore, the identification of the type of consumer considering the value of the payment ratio has been performed. The value of the coefficient shows whether the consumer is a debtor (<1) or a customer that pays in advance (>1). At the same time, the identification of the type of consumer is an important task of the management of operational cash flows of power supply companies, as the use of specific methods and tools for planning and managing cash flows is required to manage cash inflows from each group of electricity consumers. The next stage in the management of the operational cash inflow of power supply companies is the comparison of the actual value of the payment ratio with its projected value. When the actual value of the payment ratio exceeds the planned one, the projected volume of the cash flow of the power supply companies is adjusted upward. When the actual value of the payment ratio is lower than the planned one, the projected volume of cash inflow from operating activities decreases.

The Microsoft Excel Forecast function is used to forecast cash flows; it projects the value of cash inflows and outflows based on their current values. Thus, based on the financial statements of power supply companies for the period of 2015–2019 and the use of Microsoft Excel Linest and Forecast functions, linear regression equations for the net cash flow, cash inflow, and outflow of power supply companies have been constructed. As a result, the following model has been obtained:

$$TCF_{in(i)} = a_{TCFin} + b_{TCFin} \times t_i$$ (7)

$$TCF_{out(i)} = a_{TCFout} + b_{TCFout} \times t_i$$ (8)

$$TCF_{net(i)} = a_{TCFnet} + b_{TCFnet} \times t_i$$ (9)

where $TCF_{in(i)}$, $TCF_{out(i)}$, $TCF_{net(i)}$ represent the value of the total cash inflow, cash outflow, and net cash flow in the i-th period; a_{TCFin}, a_{TCFout}, a_{TCFnet} represent the constant parameters of the regression model of the total cash inflow, cash outflow, and net cash flow; b_{TCFin}, b_{TCFout}, b_{TCFnet} represent the regression coefficients of the total cash inflow, cash outflow, and net cash flow; and t_i represents the numerical order of the period from 1 (2015) to 5 (2019), which are actual values, while if t_i = 6 (2020) or 7, 8, etc., then they are planned values. Based on the use of the Microsoft Excel "Linest" function and the data on the cash inflows, cash outflows, and net cash flows of power supply companies for the period of 2015–2019, the following values of the regression coefficients and constant parameters of the linear regression model of cash flows were obtained. The constructed linear

regression models can be used to calculate the projected value of the cash inflow, cash outflow, and net cash flow of power supply companies for subsequent periods. Based on the proposed models, the values of the cash inflow, cash outflow, and net cash flow of power supply companies for 2025 ($t_i = 11$) were calculated [53,54].

The study is based on the data provided by 12 power supply companies operating in the CIS member countries. The main criterion for the selection of companies was the CIS membership of the country in which they are located, the period of operation over 5 years, and the availability of the required financial information in the context of cash flows. The research sample included Azerenerji JSC (Azerbaijan), Electric Networks of Armenia CJSC (Armenia), Telasi JSC (Georgia), ADEC JSC (Kazakhstan), NES Kyrgyzstan JSC (Kyrgyzstan), Belenergo SPA (Belarus), ERES SUE (Moldova), Rosseti PJSC (Russian Federation), Pamirenergy PJSC (Tajikistan), Turkmenenergo (Turkmenistan), Kyivenergo PJSC (Ukraine), and Karakalpak enterprise of territorial power grids (Uzbekistan).

4. Results

The level of settlement discipline of the consumers of each enterprise under consideration is different. This is evidenced by the indicators of the consolidated ratio of consumer payments shown in Figure 1.
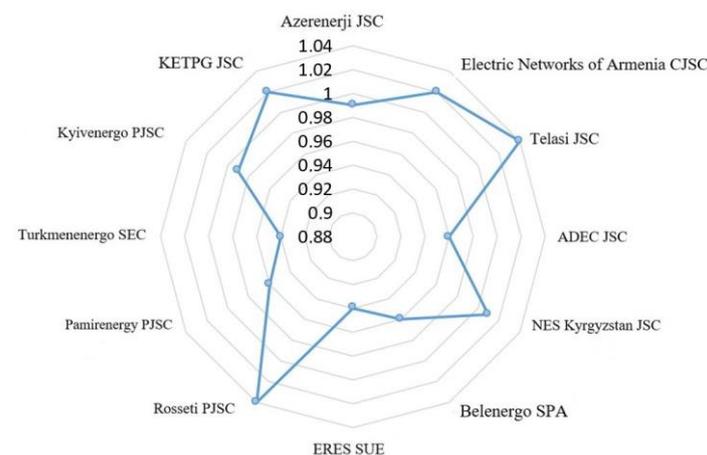

Figure 1. The consolidated ratio of consumer payments in 2019. Source: own development.

The coefficient is <1 for seven out of 12 enterprises and it is >1 for the remaining five enterprises. Thus, in 2019, seven out of 12 surveyed enterprises had problems related to settlement discipline.

In order to reflect the generalized trends that are inherent in the structural ratios of cash flows, Figure 2 shows the average coefficients of the share of operating, financial, and investing cash flows in the total cash inflow and outflow of power supply companies in 2015–2019.

As for the average structural financial ratios, which reflect the specifics of the formation of the total cash outflow of power supply companies in 2015–2019, it should be noted that the structural proportions inherent in the cash flow are also preserved here. Thus, for the majority of power supply companies over the period of 2015–2019, the basis of all payments was the cash outflow from operating activities. The highest average share of the operating cash outflow in the total cash flow can be observed in the following power supply companies: Azerenerji JSC, ADEC JSC, ERES State Unitary Enterprise, Turkmenenergo SEC, and Kyivenergo PJSC. At the same time, the average share of investing and financing cash outflows in the total cash flow is the greatest in Belenergo SPA, NES Kyrgyzstan JSC, and Telasi JSC.
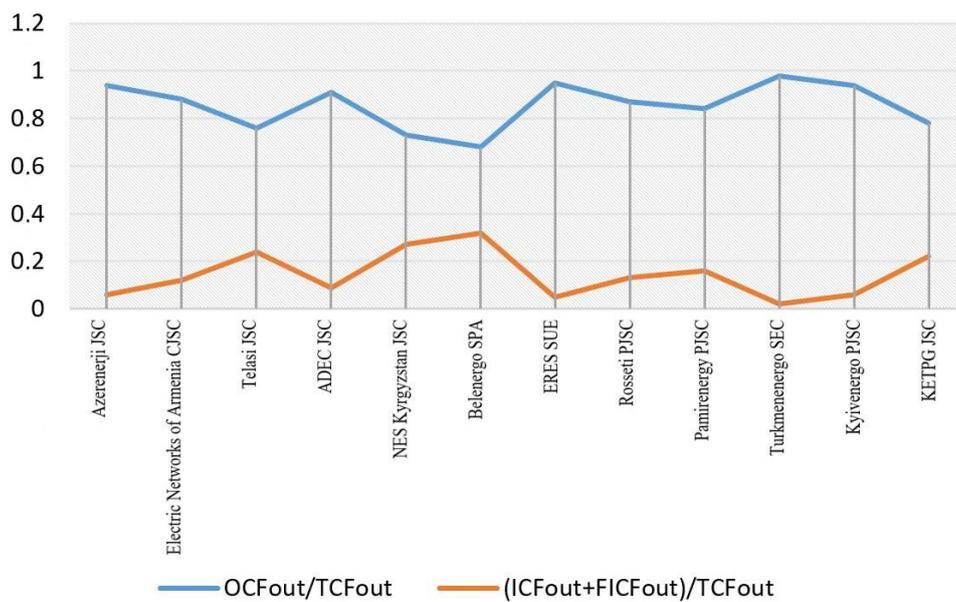
Figure 2. Average values of the coefficients of the share of cash outflows of power supply companies. Source: own development.

In order to determine the uniformity of cash inflows (cash flow) of power supply companies for the period of 2015–2019, the average value of the cash flow ($CFin$ (av)), its standard deviation ($\sigma CFin$), and the coefficient of variation ($CVCFin$) were assessed (Figure 3). The average deviation of the cash inflow reflects the range of fluctuations in the cash flow of power supply companies in 2015–2019.
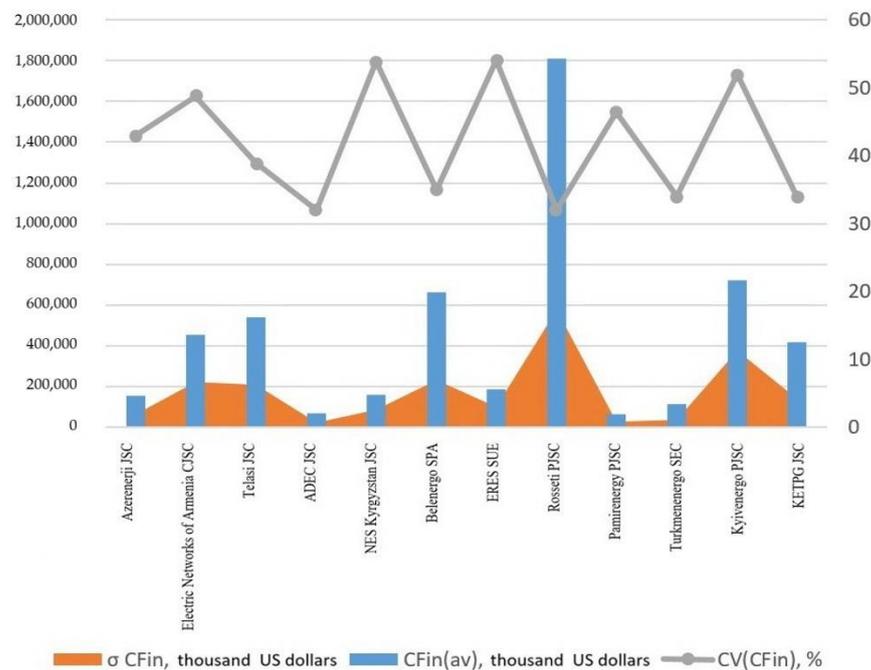

Figure 3. Indicators of the level of uniformity of the cash flow of the power supply companies under consideration. Source: own development.

On the one hand, the absolute value of the root-mean-square deviation depends on the uniformity of cash inflows over the studied period, and on the other hand, it depends on the size of the power supply company. Taking into account the above, it is rather difficult to assess the cash flow variance on the basis of the absolute value of the standard deviation. Therefore, the coefficient of variation is a fairly informative relative indicator that allows

comparing the variation in the cash flow of various power supply companies. Figure 3 shows that NES Kyrgyzstan JSC, ERES SUE (54%) and Kyivenergo PJSC (52%) are typically characterized by high cash flow variance. These enterprises have the most volatile level of cash flow. At the same time, there are power supply companies with a stable cash flow level. These are ADEC JSC (32%), Rosseti PJSC (32%), Turkmenenergo SEC (34%), and KETPG JSC (34%). The rest of the power supply companies have an average level of cash flow uniformity, and the coefficient of cash flow variance ranges from 35 to 45%.

Another important component of the study of the uniformity of cash flows is the assessment of the uniformity of cash outflows of power supply companies over the period of 2015–2019, which is shown in Figure 4.
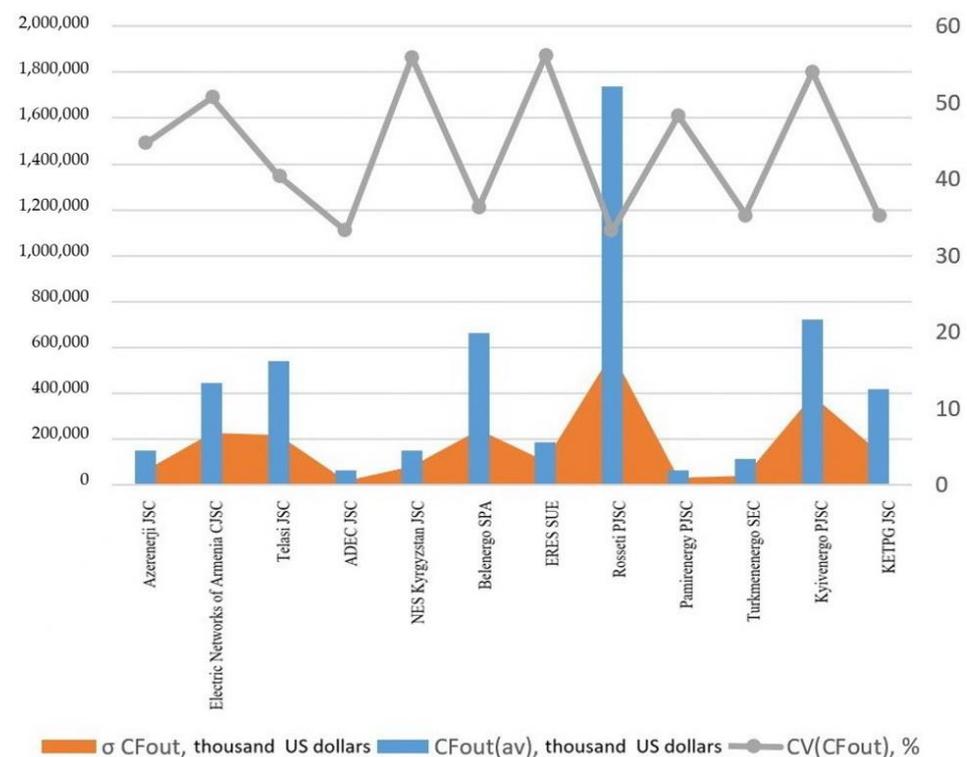

Figure 4. Indicators of the level of uniformity of the cash outflow of the power supply companies under consideration. Source: own development.

The obtained indicators (Figure 4) demonstrate that over the period under study, the volume of the cash outflow of power supply companies varies significantly. This is evidenced by the value of the standard deviation of the cash outflow and the coefficient of variation, which preserve the change in the variation of the cash inflow uniformity. In general, the values of the coefficients of variation of the cash outflow of power supply companies reflect the same trends as the values of the coefficients of variation of the cash flow of power supply companies. From the perspective of solvency, it is quite important to assess the uniformity of the net cash flow of the company, which is the basis for increasing cleared funds in the company account.

In order to project the volumes of cash inflow, cash outflow, and net cash flows of power supply companies under consideration for subsequent periods, namely until 2025, linear regression models were proposed. In particular, subsequent values can be projected on their basis. Thus, $t_i = 5$ for 2019, $t_i = 6$ for 2020, etc., while the values of the regression coefficients (b_{TCFin}, b_{TCFout}, b_{TCFnet}) and the values of the constant parameters of the linear regression model (a_{TCFin}, a_{TCFout}, a_{TCFnet}) remain fixed for all subsequent periods (Table 1).

Table 1. Projected volumes of the cash inflow, cash outflow, and net cash flows for the studied power supply companies for 2025 (based on linear regression models).

Company	R^2 (TCFin)	R^2 (TCFout)	TCFin, Thousand US Dollars	TCFout, Thousand US Dollars	TCFnet, Thousand US Dollars
Azerenerji JSC	0.93	0.94	164,590	161,298	3292
Electric Networks of Armenia CJSC	0.91	0.91	478,021	477,065	956
Telasi JSC	0.22	0.22	531,135	531,967	−832
ADEC JSC	0.91	0.92	69,577	68,463	1113
NES Kyrgyzstan JSC	0.85	0.86	149,440	149,231	209
Belenergo SPA	0.92	0.92	651,525	650,645	880
ERES SUE	0.46	0.45	180,369	180,380	−11
Rosseti PJSC	0.93	0.94	1,864,319	1,827,032	37286
Pamirenergy PJSC	0.65	0.66	66,338	65,011	1327
Turkmenenergo SEC	0.56	0.57	116,777	115,598	1179
Kyivenergo PJSC	0.86	0.86	708,179	708,675	−496
KETPG JSC	0.91	0.92	431,700	426,908	4792

Source: own development.

The obtained values of the coefficients of determination (R^2) obviously show that the linear regression quite accurately describes the trajectory of the dynamics of the cash inflow and outflow of such companies as Azerenerji JSC, Electric Networks of Armenia CJSC, ADEC JSC, Belenergo SPA, Rosseti PJSC, and KETPG JSC, whose coefficients of determination exceed 0.9. The coefficient of determination for the other companies has low or close to zero values, which indicates the low predictive power of linear regression models for these companies. Linear regression models are quite simple and versatile tools that allow projecting the values of cash inflow, cash outflow, and net cash flows of enterprises. However, in modern economic realities, linear relationships are not common.

Therefore, for the purpose of a deeper study, the functional possibilities of explaining the trends that are observed in the cash flows of enterprises were determined, and, accordingly, polynomial models were used to build their forecasting models as compared to linear and exponential models, which can more accurately reproduce the cash flow trends that took place in the previous periods. The level of detail of the models should be above 0.9 to indicate their high quality. As a result of the simulation of cash flows of power supply companies for the period of 2015–2019, polynomial multiple regression models were obtained (Table 2).

Table 2. Polynomial multiple regression models of the cash flow of the power supply companies under consideration.

Company	R^2 (TCFin)	Polynomial Multiple Regression Models of Cash Inflow, (TCFin)	R^2 (TCFout)	Polynomial Multiple Regression Models of Cash Outflow, (TCFout)
Azerenerji JSC	0.96	$y = 1531 x^2 − 1987 x + 2395$	0.96	$y = 1552 x^2 − 2762 x + 2498$
Electric Networks of Armenia CJSC	0.77	$y = 4136 x^2 − 3843 x + 22383$	0.78	$y = 4116 x^2 − 3219 x + 18391$
Telasi JSC	0.79	$y = 3639x^2 − 6591x + 18349$	0.81	$y = 3713x^2 − 5892x + 16396$
ADEC JSC	0.94	$y = 388 x^2 + 1701 x + 6720$	0.95	$y = 314 x^2 + 2474 x + 5729$
NES Kyrgyzstan JSC	0.96	$y = 1392 x^2 − 2122 x + 4768$	0.97	$y = 1352 x^2 − 1648 x + 4287$
Belenergo SPA	0.97	$y = 6051 x^2 − 8739 x + 14933$	0.97	$y = 5858 x^2 − 6832 x + 16498$
ERES SUE	0.97	$y = 1898 x^2 − 5295 x + 9548$	0.96	$y = 1858 x^2 − 472 1x + 8340$
Rosseti PJSC	0.97	$y = 12859x^2 + 24837x + 36786$	0.98	$y = 13275 x^2 + 17314 x + 32894$
Pamirenergy PJSC	0.93	$y = 794 x^2 − 3472 x + 8734$	0.93	$y = 775x^2 − 3105x + 6323$
Turkmenenergo SEC	0.18	$y = 1105 x^2 − 1874 x + 4591$	0.19	$y = 1048 x^2 − 1549 x + 6812$
Kyivenergo PJSC	0.91	$y = 6951 x^2 − 13573 x + 21847$	0.91	$y = 6634 x^2 − 9857 x + 18649$
KETPG JSC	0.91	$y = 2643 x^2 + 8934 x + 11782$	0.92	$y = 2895x^2 + 6205 x + 7892$

Source: own development based on the financial statements of power supply companies for the period of 2015–2019.

This type of regression has only one explanatory variable, which is included in the regression equations with various degrees (1, 2, 3, 4); based on the maximum magnitude of the obtained model, regression of the second, third, and fourth order is distinguished. In the context of this approach, the study assumes that the values of the cash inflow and outflow of power supply companies are formed under the influence of a large number of factors for which there is no information. In this case, the future value of the cash flow does not depend on its actual value. The values of the coefficients of determination of most obtained polynomial multiple regression models of the cash inflow and outflow of power supply companies exceed 0.9, which indicates the high possibility of extrapolating the trends of 2015–2019 to future periods. Table 3 shows that compared to the linear model, the polynomial one has higher values of the coefficients of determination; in particular, in most power supply companies, they are >0.95. Another advantage of polynomial models is the absence of multicollinearity, as different degrees of "x" are linear functions. At the same time, the regression coefficients included in the model are linear, which makes it possible to apply the ordinary least squares method. The above indicates that the projected values of the cash inflow and outflow calculated based on polynomial models fully take into account the trends that took place in the cash flows of the power supply companies under consideration over the period of 2015–2019. It is impossible to build a qualitative polynomial model for Turkmenenergo SEC on the basis of the information for the period under study. There are also companies whose polynomial models have a lower coefficient of determination that ranges between 0.77 and 0.9. The projected values of the cash flows obtained with the help of such models cannot fully reflect the trends that have been formed in the cash inflow and outflow.

Table 3. Projected values of cash inflow, cash outflow, and net cash flow of the power supply companies under study for 2025 (based on polynomial models).

No.	Company	TCFin, Thousand US Dollars	TCFout, Thousand US Dollars	TCFnet, Thousand US Dollars
1	Azerenerji JSC	165,789	159,908	5881
2	Electric Networks of Armenia CJSC	480,566	481,018	−452
3	Telasi JSC	531,169	530,481	688
4	ADEC JSC	72,379	70,937	1442
5	NES Kyrgyzstan JSC	149,858	149,751	107
6	Belenergo SPA	650,975	650,164	811
7	ERES SUE	180,961	181,227	−266
8	Rosseti PJSC	1,865,932	1,829,623	36,309
9	Pamirenergy PJSC	66,616	65,943	673
10	Turkmenenergo SEC	117,682	116,581	1101
11	Kyivenergo PJSC	713,615	712,936	679
12	KETPG JSC	429,859	426,442	3417

Source: own development.

Table 3 shows the projected values of the cash inflow, cash outflow, and net cash flows of power supply companies calculated based on the proposed polynomial multiple regression models. The results obtained can be used as projections that have a rather high degree of approximation. An important practical result, which is achieved in the process of projecting the values of cash flows of power supply companies, is the projected value of the net cash flow. If the projected value of the net cash flow is positive, the surplus cash flow is expected. When the value of the projected cash outflow is greater than the projected value of the cash flow, there will be cash flow deficit.

It is expected that most power supply companies will have a small net cash flow deficit, which in most cases can be covered by cleared funds. However, there are also companies that will have to look for opportunities to balance cash flows as high cash flow deficit and surplus are projected. The indicators for calculating the main criteria that allow us to assess the relationship between the cash inflow and outflow of power supply companies

are shown in Table 4, which contains the values of the correlation coefficients between the cash inflow and outflow and operating cash inflow and outflow.

Table 4. The correlation between the cash inflow and outflow of the power supply companies under consideration.

No.	Company	p(OCFin/OCFout)	p(TCFin/TCFout)
1	Azerenerji JSC	0.9955	0.9932
2	Electric Networks of Armenia CJSC	0.9772	1.0000
3	Telasi JSC	0.9980	0.9973
4	ADEC JSC	0.9992	0.9999
5	NES Kyrgyzstan JSC	0.9997	0.9999
6	Belenergo SPA	0.9995	0.9983
7	ERES SUE	0.9995	0.9996
8	Rosseti PJSC	0.9999	1.0000
9	Pamirenergy PJSC	0.9987	0.9998
10	Turkmenenergo SEC	0.9992	0.9969
11	Kyivenergo PJSC	0.9983	0.9997
12	KETPG JSC	0.9955	0.9932

Source: own development.

For most companies, the correlation coefficients between operating cash inflows and outflows, as well as between the total cash inflow and outflow for the period of 2015–2019 range between 0.99 and 1.00. This indicates the synchronicity between cash inflows and outflows over the period being considered. Slightly lower correlation coefficients between operating cash inflows and outflows are typically found in Electric Networks of Armenia CJSC. The projected cash flows based on the polynomial models have obvious discrepancies in the results. At the same time, two models show that in ERES SUE, there will be deficit cash flow. Companies such as Electric Networks of Armenia CJSC (according to polynomial models), Telasi JSC, and Kyivenergo PJSC (according to linear models) are also at risk. Based on all of the above, it is possible to exclude hypothesis H0 and accept hypothesis H1, since a significant degree of dependence of the level of financial stability and equilibrium of power supply enterprises on the level of synchronization and uniformity of their cash flows has been proven. One should consider that some enterprises are characterized by a high variation in incoming and outgoing cash flows, while for others, it is relatively insignificant. This feature makes it possible to identify enterprises according to the criterion of riskiness of cash flows as more or less risky from the standpoint of synchronization and uniformity of receipt (or spending) of funds. The weaker synchronicity between the cash inflow and outflow of these corporations is primarily due to the specifics of their financial and investment activities and cash flow management policies.

5. Discussion

Operating cash flow management based on the proposed methodological approach to monitoring, which is based on the calculation of planned and actual indicators of cash flows and their comparison, should be primarily implemented in the context of large consumers of electricity, which may include industrial consumers, budgetary and municipal institutions, and others. This is due to the fact that the operating cash inflow of power supply companies is most sensitive to the level of payment by the largest electricity consumers [55,56]. Considering the above, it is proposed to continuously monitor the payment ratios of the largest electricity consumers in order to control the cash flow from operating activities. Power supply companies have their own specifics in the use of funds received from their electricity consumers. It should also be taken into account that the cash flows from electricity consumers are credited to a special distribution account. In the absence of overdue debt, all funds from the distribution account are transferred to the current account of the power supply company. In the presence of overdue debt, a portion of funds can be credited to the current account, and another portion can be used to repay

the debt [57,58]. The specified feature of the state regulation of cash flows of power supply companies should be taken into account when planning and managing cash flows.

Based on the analysis of the operating cash flows of power supply companies over the period of 2015–2019, it can be asserted that the funds received from electricity consumers in the form of advance payments have the greatest share in the structure of operating cash flows. In this regard, the proposed methodology for the cash flow management and planning is exclusively focused on planning those operating cash flow components, which together make up more than 90% of its volume [13]. At the same time, the operating cash outflow of power supply companies depends on the volume of electricity purchased, average electricity rates, the amount of taxes and duties paid by power supply companies, and employee benefits [59]. In recent years, the introduction of new techniques has had the greatest impact on the cost of electricity, which leads to an increase in the cost of electricity produced by thermal power plants and combined heat and power (CHP) power stations [60]. Planned cash flow contribution ratios can reflect the planned (target) structure of cash inflow and outflow of power supply companies [61]. At the same time, the coefficients of the contribution of cash flow can be tools for controlling cash flows in the process of comparing their actual values with the planned and industry average values [24,62]. These properties of financial ratios make them versatile tools for planning and controlling the cash flows of enterprises.

The approach to long-term forecasting of cash flows developed in the study makes it possible to determine long-term benchmarks of operating cash flows that can be used in the process of planning cash flows from operating activities. The methodology for planning cash flows from the operating activities proposed in this section allows us to determine the volume of operating cash flow for the planning period. When planning cash flows from operating activities, the focus should be placed on the factors that most significantly affect the volume of operating cash flow. These factors include the cost and volume of the electricity supplied to consumers, the level of energy settlement, and rates. Consideration of the expected trends in the specified factors is the basis for planning and managing operating cash flows [56,63]. The proposed methodological approach to the management of cash flows from the operating activities of power supply companies should be based on monitoring the payment ratios of both the consumer and the company itself. The ratios described in the study are effective tools for planning and managing the operating cash flows of power supply companies [63,64].

A significant advantage of the proposed methodological approach is the fact that the coefficients of the contribution of operating, investing, and financial cash flows to the total cash inflow (outflow) can indicate target planned proportions reflecting cash inflow (outflow) for certain types of activities of power supply companies [60]. In this regard, on the one hand, they can be used as target structural indicators of the formation of planned cash inflow and outflow, and on the other hand, they can be effective tools for the management of planned cash flows.

The limitation of this study is the impossibility of its practical application in other economic sectors and spheres. This is due to the fact that the ratios of cash flows should be adjusted in order to fully take into account the specifics of a particular industry or type of activity. At the same time, the positive aspect is that the contribution coefficients of cash flows are universal tools for planning and managing cash flows, and their standard values are individual and should take into account the specifics of the enterprise.

In the future, the study can be expanded in terms of the number of companies, industries, and geographical boundaries studied. At the same time, industry averages can be formed to be used as control indicators in the cash flow management and planning.

6. Conclusions

Based on the indicators of the consolidated consumer payment ratio of the power supply companies under study, it can be argued that the level of settlement discipline of their consumers varies. In most companies, there are settlement discipline problems.

The analysis of the average structural financial ratios, which reflect the specifics of the formation of the total cash inflow and outflow of power supply companies in 2015–2019, confirmed the preservation of the structural proportions inherent in the cash flow. At the same time, for the majority of power supply companies, the basis of all payments is the cash outflow from operating activities.

The uniformity of cash inflows of the power supply companies based on the assessment of the average value of the cash flow, its standard deviation, and the coefficient of variation made it possible to determine the highest level of cash flow variance in NES Kyrgyzstan JSC, ERES SUE, and Kyivenergo PJSC. These companies are characterized by the most volatile level of cash flow. At the same time, a group of companies with stable cash inflows has been identified: ADEC JSC, Rosseti PJSC, Turkmenenergo SEC, and KETPG JSC. The uniformity of cash flows based on the assessment of the distribution of payments in the power supply companies being studied indicates a significant variation in their cash outflow. In this case, the values of the standard deviation of the cash outflow and the coefficient of variation preserve the trend of changes in the cash inflow uniformity. Generally, the values of the coefficients of variation of the cash outflow of power supply enterprises reflect the same patterns as their cash flow variation coefficients.

Forecasting the volumes of cash inflow, cash outflow, and net cash flows for the power supply companies under consideration for 2025 based on the obtained coefficients of determination made it possible to determine the companies (Azerenerji JSC, Electric Networks of Armenia CJSC, ADEC JSC, Belenergo SPA, Rosseti PJSC, and KETPG JSC) for which linear regression can fairly accurately describe the trajectory of the cash inflow and outflow. However, for the other companies, which make up 50% of the studied enterprises, the coefficient of determination has low or close to zero values, which indicates the low predictive power of the linear regression models for these companies.

Based on the polynomial cash flow multiple regression models designed for the power supply companies under study, the values of the determination coefficients were determined, which exceed 0.9 for most enterprises. This confirms the strong possibility to extrapolate the studied trends to future periods. Thus, compared to the linear model, the polynomial one confirms higher values of the determination coefficients (>0.95) for the majority of power supply companies.

The projected volumes of cash inflow, cash outflow, and net cash flows of power supply companies with the application of the described polynomial multiple regression models have a fairly high degree of approximation. At the same time, most power supply companies are expected to have a small net cash deficit that can be covered by the available cash assets. However, there are also companies that will be forced to look for opportunities to ensure balanced cash flow, as the projected cash deficit and excess cash flow are quite high. The correlations between operating cash flows and outflows, between total cash inflow and outflow of the majority of power supply companies, are high and range between 0.99 and 1. The low level of synchronization between cash inflows and outflows of the companies under study is associated, first of all, with the specifics of their financial and investment activities and the cash flow management policy.

Hypothesis H1 was adopted taking into account the proven significant dependence of power enterprises' financial stability on the synchronization and uniformity of cash flows. Since the hypotheses put forward are mutually exclusive, hypothesis H0 was rejected. The proposed methodological approach allows identifying enterprises according to the criterion of cash flow riskiness from the standpoint of cash flow synchronization and homogeneity.

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