A Note on Forecasting Errors in Capital Budgeting: a multi-firm post-audit study

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Abstract

This is a post-audit study concerning the accuracy of capital budgeting procedures. It is based on the statistical analysis of the deviations occurring between effective and forecasted performance of companies after implementing their projected investments. The forecasts were collected from a large database of applications to investment incentives submitted for the consideration of the Portuguese Governmental Agency IAPMEI during the II European Union Framework Programme. The first conclusion of the study is the significance of negative forecasting errors of post-investment sales and their implication in terms of the expected profitability. On the contrary, forecasts on future operating costs were quite accurate and errors on investment expenses revealed high volatility. Also interesting is the finding that there seems to be no relationship between the size, industry, region or investment incentives and the pattern of the errors found.

Keywords: post-auditing; capital budgeting; investments.

1. Introduction

The appraisal of investment projects is subject to the uncertainty derived from the fact that it is based on expectations (of cash flows) rather than on observed data. As an answer to this uncertainty and inherent risk, several approaches have been suggested in the literature, including scenario and sensitivity analysis or more sophisticated simulation models (e.g. the Hertz[1] method and, in general, the software programs based on Monte Carlo simulation[2]).

On the other hand, financial theory has evolved by developing models that are capable of measuring investment's expectable (systematic) risk (models such as CAPM[3] and APT[4]), enabling one to incorporate a premium in the discount rates, and so influence the acceptance or rejection of investment

[1] Hertz (1964, 1968).
[2] E.g. @Risk – Palisade Corporation (2002).
[3] Seminal papers of CAPM are Sharpe (1963; 1964), Lintner(1965) and Treynor (1961).
[4] Ross (1976).

projects. The presumption behind this procedure is that, as in the past, enterprises' profits would experience particular fluctuations to some extent correlated with market global fluctuations during the different phases of economic cycles.

That procedure is focused on the risk associated with the occurrence of future economic fluctuations. Yet, it does not deal with the analysis of the inaccuracy (error) of the forecasts made for the different revenues and costs that integrate the investment projects' cash flows. This other role is confined to the above mentioned sensitivity analysis, scenario building and simulation, which may largely gain from the knowledge acquisition that can be achieved by systematically practicing ex-post evaluation. Quoting Riggs *et al*. (1998: 460):"*The purpose of auditing investments is not to punish those who approved the proposals, any more than quality control inspections are intended to penalize a production process. The aim is to improve future analyses. How else can analysts learn whether their estimated cash flows are realistic?"*

While the answer to this question is obvious and while the utility of realizing systematic post-audits is undeniable, the empirical literature on this subject within the corporate context is scarce (examples of these studies are Gordon and Myers, 1991; Myers *et al*., 1991; Neale, 1991; Neale and Holmes, 1990; Posey *et al*., 1985; and Prueitt and Park, 1991; in a public decision environment see e.g. Boardman *et al.*; 1994; 2001). The reason for that scarcity certainly has to do with: 1) the confidentiality imposed by private firms on their own evaluations; 2) the still deficient post-evaluation and control practice in this area.

In our case, we were fortunate to have access to data obtained through the control mechanism implemented by the Portuguese public Institute IAPMEI (the Institute for the Small and Medium-sized Enterprises and Investment), concerning the evaluation of private firms' applications for investment subsidies supported by European and national public funds (the Institute is empowered by the Portuguese Government to act in this matter). Through it we could constitute a large and diversified database of investment projects, which we subjected to the statistical analysis presented in the rest of this paper[5]. This

[5] A detailed report of this research project is available in Portuguese – see Soares and Martins (2003).

analysis was intended to give new empirical evidence on several questions related to the outcome of the capital budgeting procedures usually undertaken by companies:

a) What is a normal level of forecasting accuracy in capital budgeting procedures (we can presume that these forecasts are a corollary of management accounting practices and so their accuracy will reveal the merit of these practices)?
b) How does the forecasting accuracy vary for the different items that usually integrate the operational and investment cash flows of the investment projects?
c) Are there detectable motives or justifications behind these errors?
d) Are there any pattern(s) associated with the size, region or industry of the companies, or do these characteristics have no influence on the accuracy of the forecasts?
f) Is there a direct relationship between the trend of the post-investment performance of the companies and the sign of the forecasting errors?

Before continuing our journey to unveil the answers to these questions, a previous remark must still be made. It has to do with the possibility that the analysis suffers from a bias induced by the desire of the investment promoters to influence the approval of their own applications and consequently show more profitability than they really expected. This is an hypothesis that must be considered. However, against it we should notice that it was publicly known that the approved projects would be controlled *a posteriori* by the Institute mentioned, and deviations during the execution of the projects could lead to incentives being diminished or halted (in practice, this follow up has always been more concerned with the control of the investment expenses than with the subsequent operating cash flows). Additionally, even if the direct promoters of these projects were not applying for subsidies and consequently were not subject to this external control, they could always emphasize internally (inside the limits of the company) the profitability of their proposals, in order to increase the amount of assets under their supervision and reinforce their own position. So, our analysis seems to maintain its relevance.

2. The Multi-firm Data Sample

The study is based on applications to investment incentives approved by the Portuguese Institute IAPMEI during the II European Union Framework Programme. Most of these incentives were part of a special programme that was created to support the development of the Portuguese industry in those early years of integration in the European Union (programme PEDIP – "Plano Específico para o Desenvolvimento da Indústria Portuguesa"). It included different measures, aimed at supporting business internationalization, promoting innovation in manufacturing and design, and, generally, increasing productivity and competitiveness through the adoption of new technologies. A few applications were also included in another programme designed to reinforce the industrial basis of less developed regions within the country (programme SIR – "Sistema de Incentivos de Base Regional"). The incentives included in both programmes could be of different kinds: non-refundable subsidies covering part of the amount invested by the companies; refundable subsidies paying no interests; and bonuses on the bank loan interest rate.

Considering that the II Framework Programme lasted from 1994 to 1999, the population to be studied was restricted to the oldest applications (1.1.1994 – 31.12.1996), in order to capture post-investment accounting figures (extracted from the 1996-1999 financial statements) to contrast with the forecasts considered in the applications. Moreover, the practical implementation of the study imposed the selection of a sample corresponding to 264 applications, more or less 10% of the population (2533 applications), which was analyzed in detail. The applications within the sample were chosen by a stratification procedure based on the geographical area and industry sector, in order to replicate the distribution of the population. Concerning the size distribution of the enterprises that constitute the sample, we may see that it is similar to the population distribution, with the deliberate difference that it includes more medium enterprises and fewer micro enterprises instead [6](see Table 1).

[6] The definitions considered are exclusively based on the number of workers and follow the Portuguese nomenclature that considers the upper limit for medium firms as being 500 workers.

Table 1 – Population and Sample distribution of the firms considered in the study according to their size (no. workers)

Size	Micro	Small	Medium	Large	Total
	0-9	10-49	50-499	500-...	
Population (%)	12.0	36.2	48.8	3.0	100.0
Sample (%)	4.9	35.2	57.6	2.3	100.0

For each of the applications included in the sample we collected several indicators concerning the whole firm (i.e., published accounting data concerning the firm before the investment and forecasts or published accounting data concerning the firm after the investment), since information did not exist regarding the execution of the investments separately. These indicators concerned: a) items of operating cash flows – sales, cost of goods sold and raw materials consumed[7], supplies expenses, personnel costs, earnings before interest and taxes (EBIT) and net income; b) investment cash flows on fixed assets and working capital (obtained through variations of successive balance sheets); c) and also, for complementary analysis, a physical indicator – the number of workers – and two ratios expressing the economic and financial performance – the ROA (Return on Assets Managed) and the Equity ratio (Equity/Assets).

It must be understood that this selection did not (and was not intended to) reflect the analysis undertaken by the Institute, which reflected a much broader spectrum of analysis. This one comprised multiple criteria related to the adjustment of projects to governmental industrial policy (and inherent priorities), to their own corporate strategies (in terms of the modernization of their productive process and the enhancement of their added value), to the stimulation of more cleaner and more-efficient technologies (reducing the energy burden), to the professional development of human resources, and, obviously, to the improvement of economic and financial performance of the applicants.

[7] Corresponding to the global cost of goods sold for merely commercial activities and exclusively to the cost of the raw materials when products are manufactured internally.

The selected indicators usually refer to the three-year period before the execution of the project and three years after, so for each application we computed the average of the pre-investment years, the average of the post-investment years and the average of the forecasts coincident with these last figures. We then computed relative and absolute deviations between these averages:

i) **Forecasting errors (deviations between post-investment values and the respective forecasts):**

Relative error: (post-investment average – forecasts' average)/ forecasts' average

Absolute error: post-investment average – forecasts' average

ii) **Differences between ex-post and ex-ante average values**:

Relative difference: (ex-post investment average – ex-ante investment average) / ex-ante investment average.

Absolute difference: ex-post investment average – ex-ante investment average.

Absolute errors or differences are expressed in 1000s of escudos, the Portuguese currency before the euro; differences in percentages, for the ratios; and number of workers. Absolute errors averages and absolute differences averages reflect the different size of the firms, and consequently can be, for instance, positive, if some large firms have considerable positive values, even when the majority of the firms have negative performances. Consequently, in order to express an equally-weighted point of view, we also present the percentage of positive and the percentage of negative errors. The sum of these percentages can be less then 100% when there are firms with null errors or differences. Finally, relative errors are not influenced by different scales of firms or indicators but, in contrast, can give rise to outliers when denominators are very small. In these cases, these elements were taken out of the average computation.

3. Univariate Statistical Analysis of the Forecasting Errors

We will begin our analysis of the forecasting errors found in the applications to investment incentives by looking at the operating cash flow items (Table 2 and Figure 1-A and B). At a first glance, we may conclude that sales seem to have been clearly overestimated, contrary to the almost exact prediction of costs, with the exception of personnel costs, which were slightly underestimated. These conclusions arise from looking at both the respective means and the percentages of positive or negative errors. Finally, we

can conclude from Table 2 that a negative mean of 9% in terms of the sales' relative forecasting errors has an impressive multiplier effect in terms of earnings of about 5 times (error on EBIT is 42% and on net income is 56%.

Table 2 – Operating Cash Flow Items – relative and absolute errors

Items	Relative errors					Absolute errors (1 000 Pte.)				
	N	%negative errors	%positive errors	Mean	St.Dev	N	%negative errors	%positive errors	Mean	St.Dev
Sales	264	68.6	26.5	-0.09	0.24	264	69.7	29.2	-99934	408816
Cost of goods sold and raw materials consumed	261	55.2	41.4	-0.005	0.34	261	56.3	42.9	-5163	243327
Supplies expenses	264	56.1	41.3	-0.005	0.38	264	56.8	42.4	-11135	113555
Personnel costs	264	40.2	53.8	0.03	0.27	264	42.0	56.8	7911	78306
Earnings before interest and taxes	264	83.7	15.2	-0.42	1.28	264	84.1	15.5	-67208	170956
Net income	264	83.0	15.5	-0.56	1.68	264	78.8	20.1	-35893	129282

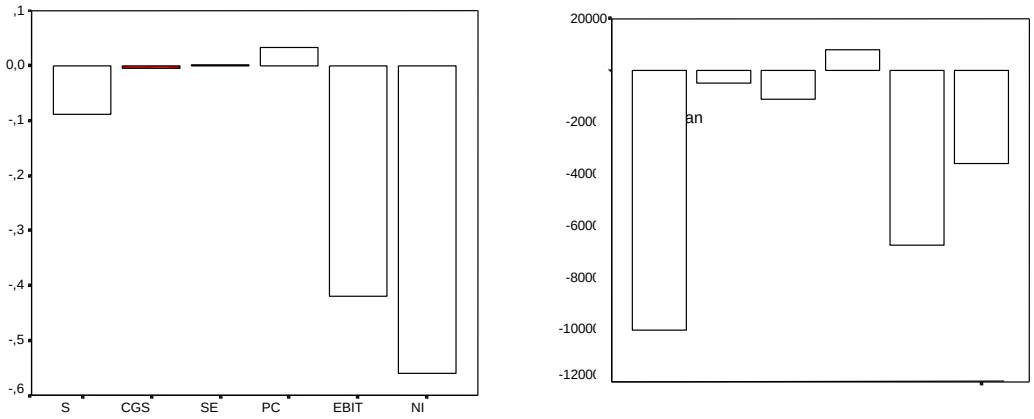

Figure 1-A and 1-B –Average relative and absolute errors in Operating Cash Flow Items (S- Sales; CGD – Cost of Goods Sold; SE – Supplies expenses; PC - Personnel Costs; EBIT – Earnings Before Interest and Taxes; NI – Net Income)

As for the investment expenses (Table 3), we may emphasize their high volatility, seeming to indicate that very different situations occur here among companies, and the positiveness of the means, which must be tested for statistical significance.

Table 3 – Investment Expenses in Fixed Assets and Working Capital – relative and absolute errors

Items	Relative errors					Absolute errors (1000 Pte)				
	N	%negative errors	%positive errors	Mean	St.Dev	N	%negative errors	%positive errors	Mean	St.Dev
Investment in Fixed Assets	240	43.3	55.0	0.50	2.79	240	42.9	57.1	2386	149733
Investment in Working Capital	240	54.6	45.0	0.40	7.48	240	42.9	56.7	31343	241756

The auxiliary variables of Table 4 show that the number of workers in the post-investment situations exceeded slightly (1.5 workers) the forecasts previously made, and that the return of all the assets managed and the equity ratio (the financial structure) were negatively influenced by the deviations analyzed above.

Table 4 – Auxiliary variables – relative and absolute errors

Items	Relative errors					Absolute errors				
	N	%negative errors	%positive errors	Mean	St.Dev	N	%negative errors	%positive errors	Mean	St.Dev
No. workers	260	49.6	46.2	0.01	0.21	260	50.4	46.9	1.51	35.18
ROA	260	80.8	16.9	-0.34	1.78	260	80.8	16.9	-5.66	6.92
Equity ratio	260	74.2	23.8	-0.16	0.54	260	75.0	24.2	-6.81	11.36

In order to reach more sustained conclusions about the errors found, we shall continue by analyzing if the means found are statistically different from zero. From Table 5, which presents the results of t-tests on the means, and adopting a significance level of 5%, we can reject the null hypothesis that the population's

mean of the forecasting errors is equal to zero for the following variables: sales, earnings before interest and taxes, net income, return on assets managed and equity ratio. In contrast, we cannot reject that the population's mean is zero for the variables: cost of goods sold and raw materials consumed, supplies expenses, personnel costs and number of workers. As for the two investment items, it is not possible to reach a conclusion, since the results for the absolute and relative errors are contradictory.

Table 5 – t-Tests on the means of the relative and absolute errors

	Relative errors			**Absolute errors**		
Items	**T**	**df**	**Mean**	**T**	**df**	**Mean**
Sales	-6.14	263	-0.09	-3.97	263	-99933
Cost of goods sold and raw materials consumed	-0.23	260	-0.005	-0.34	260	-5163
Supplies expenses	-0.22	263	-0.005	-1.59	263	-11135
Personnel costs	1.78	263	0.03	1.64	263	7911
Earnings before interest and taxes	-5.36	263	-0.42	-6.39	263	-67208
Net income	-5.40	263	-0.56	-4.5	263	-35893
Number of workers	0.56	259	0.01	0.69	259	1.51
Investment in Fixed Assets	2.80	239	0.50	0.25	239	2386
Investment in Working Capital	0.84	239	0.40	2.01	239	31343
ROA	-3.11	259	-0.34	-13.18	259	-5.66
Equity ratio	-4.87	259	-0.16	-9.67	259	-6.81

Beyond the problem of the negative performance of the investments, in terms of what had been predicted, it seemed also interesting to investigate whether this performance had led the firms to worse situations then before. In Table 6 we tested the significance of the differences between ex-ante and ex-post average values. We may see from this table that generally the means are positive, which is an expected outcome in an inflationary context (with low rates of inflation, we may add). However, earnings before interest and taxes and net income are not statistically significant for relative errors. The same occurs with the equity ratio, while the return on assets managed does not show a significant change for both indicators.

Table 6 – t-Tests on the differences between ex-ante and ex-post average values

	Relative errors			Absolute errors		
Items	**T**	**df**	**Mean**	**T**	**df**	**Mean**
Sales	2.00	258	1.94	7.53	258	425007
Cost of goods sold and raw materials consumed	2.52	258	1.56	6.90	258	239582
Supplies expenses	5.40	258	0.58	3.31	258	58357
Personnel costs	7.19	258	0.66	7.71	258	67014
Earnings before interest and taxes	1.06	258	43.16	3.14	258	39487
Net income	-0.98	258	-5.24	2.80	258	36755
Number of workers	4.61	256	0.25	1.66	256	6.36
ROA	1.26	254	0.21	1.40	254	0.62
Equity ratio	2.57	254	0.10	-0.71	254	-0.58

4. Multivariate Analysis: search for clusters

Complementary to the univariate statistical analysis, we also wanted to investigate the possible existence of clusters of enterprises conditioning the relative and absolute errors described above. The characteristics of the enterprises that were recorded in the database and that could determine the clusters were: their location (divided in three areas – North, Center and South); dimension (micro, small, medium and large); industry sector (19 two-digit sectors had been recorded); and program/measure (six different measures).

In a first step we analyzed the dendrograms of the relative and absolute errors, but were hardly able to identify more than two significant clusters. The same conclusion can be reached from Tables 7 and 8 below, which show the number of projects classified in each cluster when using a hierarchical method (Ward's) and 2 through 10 trial clusters. Moreover, the same outcomes have been obtained when using a non-hierarchical method (K-means, see Tables 9 and 10).

Table 7 – Number of projects in each cluster using Ward's method and the square of the Euclidean distance to analyze their relative errors

Cluster	Number of clusters								
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	211	211	210	210	113	113	112	112	112
2	4	3	1	1	97	90	90	90	90
3		1	3	2	1	1	1	1	1
4			1	1	2	2	2	2	1
5				1	1	7	7	4	1
6					1	1	1	3	4
7						1	1	1	3
8							1	1	1
9								1	1
10									1
Total	215	215	215	215	215	215	215	215	215

Table 8 – Number of projects in each cluster using Ward's method and the square of the Euclidean distance to analyze their absolute errors

Cluster	*Number of clusters*								
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	230	230	134	133	133	133	133	133	129
2	7	1	96	96	95	95	95	89	89
3		6	1	1	1	1	1	6	4
4			6	6	1	1	1	1	6
5				1	6	5	1	1	1
6					1	1	4	1	1
7						1	1	4	1
8							1	1	4
9								1	1
10									1
Total	237	237	237	237	237	237	237	237	237

Table 9 – Number of projects in each cluster using a non-hierarchical method to analyze their relative errors

Cluster	*Number of clusters*								
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	211	2	7	183	24	2	1	3	1
2	4	9	2	26	1	42	6	1	61
3		204	204	2	2	2	3	5	1
4			2	2	185	162	109	3	1
5				2	1	5	1	1	3
6					2	1	2	139	3
7						1	1	1	1
8							92	1	5
9								61	138
10									1
Total	215	215	215	215	215	215	215	215	215

Table 10 – Number of projects in each cluster using a non-hierarchical method to analyze their absolute errors

Cluster	*Number of clusters*								
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	3	230	2	2	1	2	88	76	4
2	234	2	2	77	228	1	2	1	1
3		5	6	2	2	1	1	1	77
4			227	154	3	1	1	2	3
5				2	2	133	137	63	69
6					1	2	5	85	1
7						97	2	6	1
8							1	2	2
9								1	78
10									1
Total	237	237	237	237	237	237	237	237	237

The tables above seem to reveal that there is no significant segmentation of the forecasting errors related with any of the recorded characteristics of the firms. However, in order to validate this conclusion we still should look at the distribution of the firms in each cluster according to the analyzed characteristics. We can see this distribution in Tables 11 and 12 for the 8-clusters case, the number for which, with both methods and errors, we obtain a more similar number of cases in each cluster. It is clear from the analysis of both tables that no relationship emerges, and so the industry, the size , the region and the incentive program of the applications and respective firms seem to have no influence on the forecasting errors found ex-post.

Table 11 – Distribution of the projects by the different clusters using a non-hierarchical method to analyze their relative errors (segmentation by SIC, dimension, program/measure and region)

		8 *clusters*							
		***Cluster* 1**	***Cluster* 2**	***Cluster* 3**	***Cluster* 4**	***Cluster* 5**	***Cluster* 6**	***Cluster* 7**	***Cluster* 8**
SIC	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
SIC 14	4				1				3
SIC 15	14			1	9				4
SIC 17	22		2		8		1		11
SIC 18	12				8				4
SIC 19	19		1		11				7
SIC 20	13		1	1	3				8
SIC 21	3				1				2
SIC 22	10				8				2
SIC 24	17			1	11				5
SIC 25	7				2				5
SIC 26	29		1		17				11
SIC 27	4					1			3
SIC 28	15				9			1	5
SIC 29	17	1			6				10
SIC 31	4				2				2
SIC 32	2				2				
SIC 34	3				1				2
SIC 35	1				1				
SIC 36	19		1		9		1		8
Total	215	1	6	3	109	1	2	1	92
Dimension									
Micro	9				4				5
Small	73	1	2	1	34	1			34
Medium	127		3	2	67		2	1	52
Large	6		1		4				1
Total	215	1	6	3	109	1	2	1	92
Program/Measure									
33<750000	77		1	2	39			1	34
33>750000	27		2		17		1		7
34	6				5				1
35	49	1	1		25		1		21
36	4				2				2
71	52		2	1	21	1			27
Total	215	1	6	3	109	1	2	1	92
Region									
North	115	1	4		51		1	1	57
Center	53		1	1	35	1			15
South	47		1	2	23		1		20
Total	215	1	6	3	109	1	2	1	92

Table 12 – Distribution of the projects by the different clusters using a non-hierarchical method to analyze their absolute errors (segmentation by SIC, dimension, program/measure and region)

		8 *clusters*							
		***Cluster* 1**	***Cluster* 2**	***Cluster* 3**	***Cluster* 4**	***Cluster* 5**	***Cluster* 6**	***Cluster* 7**	***Cluster* 8**
SIC	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
SIC 14	5	4				1			
SIC 15	16	5				10	1		
SIC 17	23	9				13		1	
SIC 18	12	5				7			
SIC 19	19	6				13			
SIC 20	16	8			1	7			
SIC 21	3	1		1		1			
SIC 22	11	1				10			
SIC 24	17	5	1			10	1		
SIC 25	7	5				2			
SIC 26	33	12				21			
SIC 27	4	2				2			
SIC 28	18	7				11			
SIC 29	19	8				9	1		1
SIC 31	4	1	1			1	1		
SIC 32	2					2			
SIC 34	3	1				1		1	
SIC 35	1					1			
SIC 36	24	8				15	1		
Total	237	88	2	1	1	137	5	2	1
Dimension									
Micro	12	4			1	6			1
Small	83	38				45			
Medium	136	46	1	1		85	3		
Large	6		1			1	2	2	
Total	237	88	2	1	1	137	5	2	1
Program/Measure									
33<750000	81	34	1			44	1	1	
33>750000	27	4	1			18	3	1	
34	6	2				4			
35	53	17				36			
36	4			1		2	1		
71	66	31			1	33			1
Total	237	88	2	1	1	137	5	2	1
Region									
North	124	52	2	1			3	2	
Center	60	21					2		1
South	53	15			1				
Total	237	88	2	1	1	137	5	2	1

5. Conclusion

It is very difficult to have access to exclusive ex-post information about investment projects, especially if we want to analyze the entire life of the projects and embrace diverse industry sectors and firms. The empirical study described in this paper overcame this problem through the access to a large dataset of applications for investment incentives and the subsequent post-investment financial statements.

The first outcome of the study was the significance of negative forecasting errors on future sales and its implication in terms of companies' expected profitability after the investments. On the contrary, forecasts on future operating costs were quite accurate. As for errors on investment expenses, they revealed high volatility, possibly due to delays in the execution of the projects. Finally, there seems to be no relationship between the size of the firms, industry, region and investment incentives and the pattern of the errors found. Moreover, the percentages of positive and negative errors on earnings forecasts are very similar regardless of the size of the firms (e.g., for EBIT the percentages of positive absolute deviations belong to the narrow range [83.3%,84.9%], while for negative deviations the values oscillate only between 15.1% and 16.7%).

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