Innovation and Financial Performance of New Energy Vehicle Firms Under the Dual-Carbon Goals

--Evidence from the 2012–2024 New Energy Demonstration City Pilot Policy

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Abstract. Under the push of the dual-carbon goals and the broader shift toward green development, the new energy vehicle industry has moved to the center of China's path to carbon peaking and carbon neutrality. The New Energy Demonstration City Pilot Policy, introduced in 2014, changed how cities used energy, pulled related industries together, and gave green technology more room to grow. It also created a policy setting that mattered for new energy vehicle firms.

What is still less clear is how far this policy changed firms' innovation spending and financial results, and whether that effect looked the same across different firms. This paper studies Chinese A-share listed new energy vehicle companies from 2012 to 2024 and treats the 2014 policy as a quasi-natural experiment. Using a difference-in-differences model, it looks at the policy's causal effect on innovation input and overall financial performance.

Keywords: new energy vehicles; innovation input; financial performance; new energy demonstration cities

1 Introduction

Energy sits at the base of economic growth. It has also been one of the main engines behind China's rapid development. But once the country formally set the goals of peaking carbon emissions before 2030 and reaching carbon neutrality before 2060, the old growth model started to show its limits more clearly.

This is where the problem gets hard. China's industrial economy still leans heavily on fossil fuels, while low-carbon technologies have spread more slowly than policy goals would like. That creates a kind of lock-in. High-carbon industries do not just consume energy. They are tied to jobs, tax revenue, and local resource allocation. So the groups connected to them often have every reason to keep the existing system in place. And that makes low-carbon transition much harder than it looks on paper.

Against that background, the rise of the new energy vehicle industry matters for a simple reason. It gives China one of the clearest ways to loosen that lock. As a strategic emerging industry, new energy vehicles help cut energy use and emissions, but they

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also pull other sectors along with them. Upstream, they push advances in batteries and new materials. Downstream, they feed demand for smart connectivity and related systems. The effect is wider than the car itself.

In 2014, the National Energy Administration issued the Notice on Announcing the First Batch of New Energy Demonstration Cities (Industrial Parks). It named 81 cities and 8 industrial parks as part of the first batch of pilots. That decision gave the new energy sector, and especially new energy vehicle firms, a stronger policy foothold. It supported charging infrastructure, market subsidies, and industrial planning. In practice, that meant more room for technical progress and a better setting for market expansion.

This paper takes Chinese A-share listed new energy vehicle firms from 2012 to 2024 as its sample and asks a direct question: under the dual-carbon policy setting, how did the New Energy Demonstration City Pilot Policy affect firms' innovation input and financial performance? The argument here is straightforward. Policy changed the incentives firms faced, and firms responded. To test that, the paper uses a difference-in-differences model to identify the policy shock, trace the link between policy support, firm innovation behavior, and financial outcomes, and offer evidence that may help refine both policy design and firm strategy.

2 Theoretical Analysis and Research Hypotheses

2.1 The Policy's Effect on Firms' R&D Investment

R&D spending is where a firm's technological edge begins. It is also where low-carbon transition becomes real rather than rhetorical. The Porter Hypothesis helps frame this part of the story[1]. If environmental regulation is designed well, it does more than restrict firms. It can push them to spend more on research, raise efficiency, and turn outside pressure into a source of competitive advantage.

That logic fits this policy fairly well. The New Energy Demonstration City Pilot Policy combines pressure with support, and both matter.

One side is institutional pressure. Pilot cities were required to raise the share of renewable energy used in electricity, heating, transport, and construction, and they were assessed on that basis[2]. For new energy vehicle firms, this was not some distant policy signal. It translated into direct pressure to upgrade technology. If firms wanted to keep pace with higher policy expectations around energy use, cleanliness, and intelligent functions, they had to put more money into core R&D[3].

The other side is support. The policy asked policy-oriented financial institutions, including the China Development Bank, to give priority credit support to relevant projects. That lowered financing pressure for firms in pilot areas and made it easier to fund research. The super deduction for R&D expenses pushed costs down further. And once charging infrastructure improved and green consumption gained traction in pilot cities, market demand for new energy vehicles grew. Firms then had a clearer reason to spend more on research because the market they were building for no longer looked hypothetical[4].

H1: The New Energy Demonstration City Pilot Policy increases innovation input in new energy vehicle firms.

2.2 The Policy's Effect on Firms' R&D Output

Input is one thing. Output is another. Whether R&D spending turns into patents and usable technology depends a lot on the environment around the firm. National innovation system theory is useful here because it points to the role of the regional setting[5]. Policy support can shape that setting in ways that make knowledge move faster and turn research effort into actual output.

This policy seems to work through three main channels.

The first is industrial concentration. Through tax incentives, land supply, and financial support, the policy drew new energy firms into pilot cities and helped them cluster there. Once firms are packed closer together, knowledge moves more easily. Information frictions fall. Firms learn from one another, sometimes directly and sometimes just by watching. That tends to raise the patent output generated by each unit of R&D spending.

The second is collaborative innovation. The policy encouraged work on smart grids, energy storage, and related technologies. That gave new energy vehicle firms more opportunities to work with suppliers, battery makers, software firms, and other upstream and downstream actors. Patent output then becomes broader in scope because the technology base itself is broader[6].

The third is competitive pressure. Pilot cities moved earlier. That early move sharpened competition. Firms had to focus their R&D more tightly on core technologies that could actually set them apart, which pushed patent production forward[7].

H2: The New Energy Demonstration City Pilot Policy raises the R&D output of new energy vehicle firms.

2.3 The Policy's Effect on Firms' Financial Performance

Financial performance captures how well a firm is running and whether it is creating value in a durable way. Green policy can pull that in two directions. In the short run, compliance can raise costs. Over a longer horizon, better efficiency, stronger products, and a bigger market may outweigh those costs.

This paper expects the policy to improve financial performance through three paths.

The first is efficiency. The policy encouraged firms to use renewable energy such as solar and wind power instead of relying only on traditional fossil fuels. That can lower both energy use and procurement costs in production, which feeds into return on assets. And as new energy technology gets cheaper, that cost effect should become easier to see[8].

The second is market expansion. Pilot cities improved the local environment for new energy vehicle use[9]. More charging facilities and stronger public acceptance of green travel increased demand. When demand rises, firms gain sales, scale, and market share. The effect on financial results is not abstract. It shows up in revenue.

The third is the conversion of innovation into market return. If the policy pushes firms to spend more on R&D, and if that R&D leads to more competitive products, then those products should bring stronger pricing power and better profitability. That is the basic logic. And it is a reasonable one.

H3: The New Energy Demonstration City Pilot Policy improves the financial performance of new energy vehicle firms.

3 Model Construction

3.1 Variable Definitions

The study uses three main outcome variables: R&D investment, R&D output, and financial performance. The policy variable is the DID term. A set of firm-level controls is also included. The definitions are in table 1 shown below.

Table 1. Variable Definitions

Variable Symbol	Variable Name	Definition
RD	R&D investment	Ratio of R&D expenditure to operating revenue
lnPatent	R&D output	Natural logarithm of the number of patent applications filed by the firm in the current year
ROA	Return on total assets	Net profit / average total assets
DID	New Energy Demonstration City Pilot Policy	Assigned a value of 1 if the firm is affected by the pilot policy
Size	Firm size	Natural logarithm of total assets at year-end
Lev	Leverage ratio	Total liabilities / total assets
Growth	Revenue growth rate	Increase in current-year operating revenue / total operating revenue in the previous year
Top1	Shareholding ratio of the largest shareholder	Shares held by the largest shareholder / total shares
ListAge	Listing age	Natural logarithm of the number of years since listing
Board	Board size	Natural logarithm of the number of board members
Indep	Proportion of independent directors	Number of independent directors / total number of directors
Dual	CEO-chair duality	Equals 1 if the chairman and general manager are the same person; otherwise 0

3.2 Descriptive Statistics

The final sample includes 3,604 firm-year observations for listed new energy vehicle companies from 2012 to 2024. Some variables show clear skewness and a fair amount of spread, which suggests that later regressions should be read with some care. That is why the paper considers standard fixes such as variable transformation and robust standard errors. (table 2)

Table 2. Descriptive Statistics

VarName	Obs	Mean	SD	Median	Min	Max
RD	3604	0.048	0.030	0.044	0.000	0.223
lnPatent	3604	2.332	1.762	2.398	0.000	6.096
ROA	3604	0.042	0.055	0.042	-0.208	0.171
Treat	3604	0.360	0.480	0.000	0.000	1.000
Post	3604	0.322	0.467	0.000	0.000	1.000
DID	3604	0.322	0.467	0.000	0.000	1.000
Size	3604	22.420	1.311	22.247	20.081	26.465
Lev	3604	0.451	0.181	0.458	0.080	0.883
Growth	3604	0.168	0.320	0.118	-0.483	1.677
Top1	3604	0.326	0.147	0.306	0.069	0.712
ListAge	3604	2.075	0.858	2.197	0.000	3.401
Board	3604	2.100	0.191	2.197	1.609	2.639
Indep	3604	37.469	5.181	33.330	33.330	57.140
Dual	3604	0.354	0.478	0.000	0.000	1.000

3.3 Correlation Analysis

This section reports Pearson correlation coefficients for the main variables. The DID term is positively correlated with RD, lnPatent, and ROA, with coefficients of 0.157, 0.128, and 0.064. That gives an early signal that the policy is associated with more R&D spending, more patent output, and better financial performance. (table 3)

Table 3. Correlation Analysis

	RD	lnPatent	ROA	DID	Size	Lev	Growth	Top1	ListAge	Board	Indep	Dual
RD	1											
lnPatent	0.270***	1										
ROA	-0.121***	0.123***	1									
DID	0.157***	0.128***	0.064***	1								
Size	-0.111***	0.238***	-0.018	0.048***	1							
Lev	-0.107***	0.051***	-0.433***	0.005	0.519***	1						
Growth	-0.077***	0.015	0.312***	0.070***	0.044***	0.023	1					
Top1	-0.123***	0.043**	0.158***	-0.128***	0.066***	-0.034**	-0.027	1				
ListAge	-0.125***	-0.089***	-0.243***	0.032*	0.549***	0.390***	-0.123***	-0.067***	1			
Board	-0.045***	0.161***	-0.017	-0.003	0.247***	0.132***	-0.013	-0.042**	0.149***	1		
Indep	0.035**	-0.023	-0.010	0.042**	-0.001	-0.042**	0.001	0.049***	-0.043***	-0.567***	1	
Dual	0.111***	0.019	0.067***	0.046***	-0.080***	-0.035**	0.075***	-0.022	-0.227***	-0.160***	0.132***	1

The control variables do not show large correlations with the main explanatory variable. So at least from this table, serious multicollinearity does not look like the main concern.

3.4 Baseline Regression

To test the policy effect more formally, the paper sets up the following regression model with firm-level controls, industry fixed effects, and year fixed effects:

$$RD_{it} = \beta_0 + \beta_1 * DID_{it} + \beta_2 * Size_{it} + \beta_3 * Lev_{it} + \beta_4 * Growth_{it} + \beta_5 * Top1_{it} + \beta_6 * ListAge_{it} + \beta_7 * Board_{it} + \beta_8 * Indep_{it} + \beta_9 * Dual_{it} + \mu_j + \theta_t + \varepsilon_{it}$$

$$lnPatent_{it} = \beta_0 + \beta_1 * DID_{it} + \beta_2 * Size_{it} + \beta_3 * Lev_{it} + \beta_4 * Growth_{it} + \beta_5 * Top1_{it} + \beta_6 * ListAge_{it} + \beta_7 * Board_{it} + \beta_8 * Indep_{it} + \beta_9 * Dual_{it} + \mu_j + \theta_t + \varepsilon_{it}$$

$$ROA_{it} = \beta_0 + \beta_1 * DID_{it} + \beta_2 * Size_{it} + \beta_3 * Lev_{it} + \beta_4 * Growth_{it} + \beta_5 * Top1_{it} + \beta_6 * ListAge_{it} + \beta_7 * Board_{it} + \beta_8 * Indep_{it} + \beta_9 * Dual_{it} + \mu_j + \theta_t + \varepsilon_{it}$$

Here, i denotes the firm, j the industry, and t the year, μ_j captures industry fixed effects, θ_t captures year fixed effects and ε_{it} is the random error term.

The coefficients tell a fairly clear story.

In Column (1), the coefficient on DID is 0.007 and passes the 5% significance level. That suggests the pilot policy raised firms' R&D investment. In Column (2), the DID coefficient is 0.390 and significant at the 1% level, which points to a clear rise in R&D output. In Column (3), the DID coefficient is 0.008 and also significant at the 1% level, suggesting an improvement in financial performance.

So the baseline results move in one direction. The policy appears to push firms to spend more on innovation, produce more innovation output, and perform better financially. (table 4)

Table 4. Baseline Regression Results

	(1) RD	(2) lnPatent	(3) ROA
DID	0.007**	0.390***	0.008***
	(2.588)	(2.631)	(2.959)
Size	-0.001	0.517***	0.015***
	(-0.968)	(6.515)	(10.471)
Lev	-0.005	-0.096	-0.167***
	(-0.660)	(-0.253)	(-16.678)
Growth	-0.009***	-0.326***	0.049***
	(-4.678)	(-3.234)	(15.644)
Top1	-0.011	0.485	0.042***
	(-1.479)	(0.993)	(4.623)
ListAge	-0.003**	-0.527***	-0.011***
	(-2.223)	(-5.599)	(-5.548)
Board	0.009	1.341***	-0.014*
	(1.641)	(3.084)	(-1.856)

Indep	0.000	0.014	-0.001***
	(0.857)	(0.901)	(-2.888)
Dual	0.003*	-0.084	0.003
	(1.775)	(-0.694)	(1.105)
_cons	0.061**	-11.682***	-0.164***
	(2.465)	(-6.420)	(-4.786)
Industry fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
N	3604	3604	3604
r2	0.243	0.278	0.407
r2_a	0.235	0.271	0.401
F	7.067	12.223	72.779

Note: *** p < 0.01, ** p < 0.05, * p < 0.1. t-values are reported in parentheses.

3.5 Parallel Trends

R&D Investment. The difference-in-differences setup depends on a basic assumption: before the policy, firms in pilot and non-pilot areas followed similar trends. For this test, 2014 is treated as the base year and set to zero, while the remaining years are coded with time dummies.

The figure shows that before the policy took effect, the confidence intervals around the estimated coefficients include zero. That means there was no clear difference in R&D investment trends between the treatment group and the control group before the policy. After the policy, the coefficients move above zero, which suggests that the effect on R&D investment gradually appeared over time. (Fig. 1)

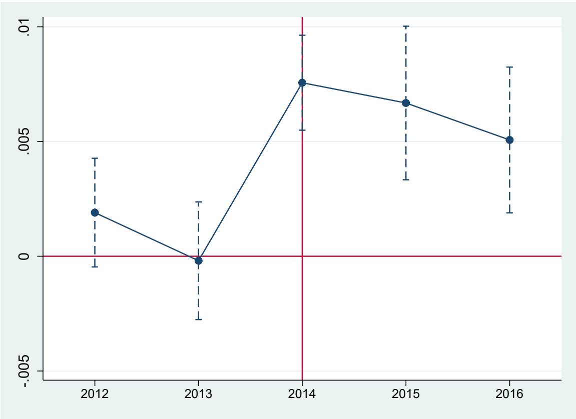

Fig. 1. Parallel Trends Test:R&D Investment

R&D Output. The same logic applies to R&D output. Again, 2014 is used as the base year, and the remaining years are assigned dummy variables for the parallel trends test.

Before the policy was implemented, the confidence intervals include zero. That supports the view that pilot and non-pilot firms were moving along similar paths in R&D output before treatment. After implementation, the estimated coefficients turn positive, which suggests that the policy effect on R&D output built up over time. (Fig. 2)

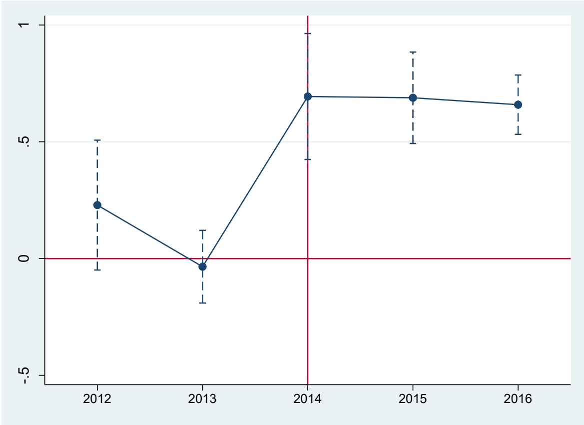

Fig. 2. Parallel Trends Test:R&D Output

Financial Performance. Financial performance is tested the same way. The paper again uses 2014 as the base year and checks whether the treatment and control groups were already diverging before the policy shock.

They do not appear to be. Before implementation, the confidence intervals include zero. After implementation, the coefficients rise above zero, which suggests that the policy's effect on financial performance also emerged gradually rather than all at once. (Fig. 3**)**

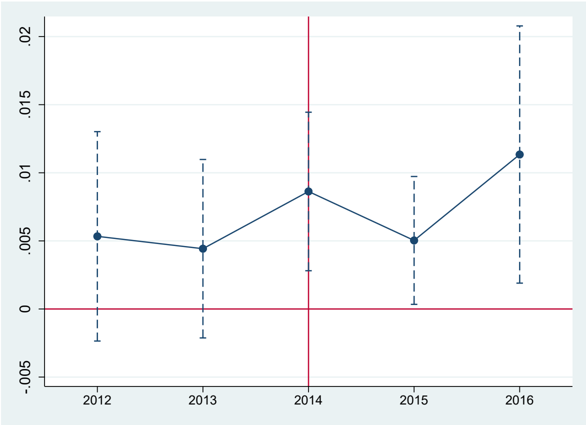

Fig. 3. Parallel Trends Test:Financial Performance

3.6 Robustness Tests

The paper also runs a PSM+DID specification as a further check. The results stay close to the baseline estimates.In Columns (1) and (2), the DID coefficient remains positive and significant at the 5% level, which supports the earlier conclusion that the policy raised firms' innovation activity. In Column (3), the DID coefficient remains positive and significant at the 5% level as well, which supports the earlier finding on financial performance. The baseline story holds up. (table 5)

Table 5. Robustness Tests

	(1) RD	(2) lnPatent	(3) ROA
DID	0.007**	0.390***	0.008***
	(2.589)	(2.625)	(2.937)
Size	-0.001	0.519***	0.015***
	(-0.959)	(6.523)	(10.457)
Lev	-0.005	-0.104	-0.167***
	(-0.665)	(-0.272)	(-16.652)
Growth	-0.009***	-0.323***	0.048***
	(-4.629)	(-3.179)	(15.569)
Top1	-0.011	0.479	0.042***
	(-1.480)	(0.980)	(4.602)
ListAge	-0.003**	-0.528***	-0.011***
	(-2.222)	(-5.607)	(-5.559)
Board	0.009	1.342***	-0.015*
	(1.646)	(3.089)	(-1.864)
Indep	0.000	0.015	-0.001***
	(0.860)	(0.905)	(-2.892)
Dual	0.003*	-0.084	0.003
	(1.770)	(-0.698)	(1.109)
_cons	0.061**	-11.713***	-0.165***
	(2.448)	(-6.433)	(-4.783)
Industry fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
N	3602	3602	3602
r2	0.242	0.278	0.406
r2_a	0.235	0.271	0.400
F	7.013	12.256	72.301

4 Conclusions and Recommendations

4.1 Research Conclusions

First, the New Energy Demonstration City Pilot Policy clearly increased innovation input among new energy vehicle firms. The baseline regression shows a coefficient of 0.007 for R&D input. In the paper's logic, that supports the Porter Hypothesis in the setting of China's new energy policy. It suggests that a well-designed environmental policy can push firms to spend more on research through both constraint and support. The parallel trends test tells the same story from another angle: after the policy was introduced, firms in the treatment group kept increasing their R&D input. The effect did not appear all at once. It accumulated.

Second, the policy also raised R&D output. The coefficient on patent-based R&D output is 0.390, which suggests that the policy did more than make firms spend more. It also improved what that spending produced.

Third, the policy improved financial performance. The coefficient on return on assets is 0.008. The paper's point here is straightforward: green policy and firm profitability are not pulling in opposite directions in this case. They move together.

Fourth, the policy effect is gradual. Before implementation, the treatment and control groups did not show significant differences in innovation input, R&D output, or financial performance. After implementation, the effect appeared step by step and kept strengthening. That matters, because it suggests the gains from the policy took time to work through firms rather than showing up immediately.

4.2 Policy Recommendations

Government Level. The first task is to keep improving the policy system for new energy demonstration cities and make different policies work together better. The paper shows that the pilot policy improved both innovation and performance. Based on the experience of the first batch of pilots, the National Energy Administration, working with other departments, could expand the pilot scope at the right time and shift the policy focus away from simple demonstration toward a model that combines innovation-driven growth with market cultivation. Science and technology policy, industrial policy, financial policy, and new energy policy should also be aligned more closely. Otherwise support gets scattered.

The second task is to improve the innovation incentive system and make R&D subsidies more targeted. The paper finds that the policy lowered the threshold for research spending, but firms still differ in how efficiently they turn that spending into results. So a blanket subsidy approach is probably too blunt. A better path would be to move toward competitive support and a differentiated subsidy system tied to innovation performance.

The third task is to improve charging infrastructure and the consumer environment for new energy vehicles. The results suggest that market expansion is one of the main channels through which the policy improves financial performance. Local governments should incorporate charging infrastructure into overall urban planning and place facilities more carefully in residential communities, public parking lots, and expressway service areas. That is how you reduce charging anxiety in practice. And there is room for better business models here too, including cooperation among charging operators, grid companies, and property management firms, along with service models such as integrated solar-storage-charging systems and battery swapping. Subsidy policy for vehicle adoption should also keep adjusting with changes in technology and cost.

The fourth task is to guide industrial concentration more carefully and build a stronger setting for collaborative innovation. The paper treats industrial concentration as one of the main channels behind higher R&D output. Local governments should plan cluster development around actual regional strengths and existing industrial foundations, rather than repeating the same low-level construction everywhere. Leading firms should be encouraged to form innovation consortia with universities and research institutes and focus on hard technical problems such as battery energy density, intelligent connected vehicle technology, and key materials. Patent pools and intellectual property alliances also make sense here, because research output matters more when firms can actually use it.

The fifth task is to build a regular evaluation system and adjust policy in time. The policy effect changes over time, so evaluation cannot be one-off. Governments should collect firm-level data on a continuing basis and assess policy outcomes with proper methods, then adjust policy priorities and support tools accordingly. Measures that work should be extended. Weak ones should be fixed or removed. And there should also be an exit mechanism. Once a policy has done its job, it should be withdrawn or redesigned before dependence sets in.

Enterprise Level. Firms should first make full use of the policy window and keep investing in core technologies. The pilot policy gives firms a better institutional setting and better market conditions for innovation. New energy vehicle firms should treat innovation as a core growth strategy and keep spending on the technologies that actually matter, including power batteries, drive motors, and electronic control systems. They should also look ahead to next-generation technologies such as solid-state batteries, hydrogen fuel cells, and intelligent connectivity. But more spending alone is not enough. Firms need to manage the full life cycle of R&D projects so that resources keep flowing to the areas that create real value.

Firms should also deepen open innovation if they want better R&D output. Pilot cities create a regional innovation setting that firms can use, but they still have to use it. That means closer technical cooperation with upstream and downstream firms through joint R&D platforms, shared testing resources, and joint applications for major science and technology projects. It also means deeper cooperation with universities and research institutes so that basic research can move into industrial use. And firms should stay active in international technology exchange where it helps them absorb advanced techniques and raise their own innovation capacity.

Resource allocation matters too. Firms need to turn policy support into actual financial results. In production, that means replacing traditional energy with renewable energy where possible, cutting both costs and carbon emissions, and improving efficiency through intelligent manufacturing and lean management. In the market, it means using the better consumer setting in pilot cities to respond more accurately to demand and improve product structure. In finance, it means using policy-based financing support and tax incentives well enough to improve capital structure, cut financing costs, and raise the efficiency of capital use.

But firms cannot assume the policy environment will stay still. They need stronger strategic management if they want to handle policy shifts and market change. The paper's last recommendation is clear on this point: firms should track policy direction and market movement closely, build early-warning and rapid-response capacity, and adjust product planning and market strategy when technology iteration or consumer upgrading starts to change the field. Risk management belongs here too, including the ability to identify and respond to technology risk, market risk, and policy risk. That part never really goes away.

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