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Instrument–Timing Fit in Public Financial Support for High-Growth Firms: Evidence from Iran's Knowledge-Based Firms Program

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Abstract

High-growth firms are central to entrepreneurship and innovation policy, yet they remain difficult targets for public support because rapid growth is heterogeneous, episodic and weakly persistent. This article examines whether the association between public financial support and high-growth status depends on both the type and timing of the support instrument. Using administrative data on 2,981 certified knowledge-based firms in Iran, the study identifies high-growth firms through the Birch index based on real revenue growth and three thresholds: the top 5, 10 and 20 percent of the growth distribution. The empirical analysis estimates logit models that distinguish among loans, guarantees and tax exemptions received before or at the beginning of the growth window and those received during the growth window. The findings show that loans received during the growth period have the strongest and most stable positive association with high-growth status. Earlier loans do not show the same pattern. Guarantees display a weaker and less consistent association, while tax exemptions are not significantly associated with high-growth status. The results suggest that public financial support should be understood through an instrument–timing fit perspective: liquidity-providing instruments appear most relevant when they coincide with active scaling needs. The article contributes to high-growth firm policy research by shifting attention from support volume to the alignment between instrument type, timing and firm growth stage.

1. Introduction

High-growth firms (HGFs) occupy a central place in entrepreneurship, firm-growth and innovation policy because a small minority of firms accounts for a disproportionate share of employment creation, sales expansion, innovation and economic dynamism. Their importance has shifted research attention from average firm growth toward the upper tail of the growth distribution. Yet rapid growth is rare, irregular and weakly persistent, making HGFs difficult to identify before growth occurs and challenging targets for public policy (Coad et al., 2014; Henrekson & Johansson, 2010; OECD, 2010).

This creates a policy dilemma. Although firms that eventually achieve high growth can make substantial economic contributions, conventional winner-picking strategies depend on the ability of public agencies to identify them ex ante. Growth may instead emerge around trigger points such as large contracts, market entry, product commercialization or organizational change. A more useful policy question is therefore not simply which firms should be selected, but which forms of support are associated with high-growth outcomes and at what stages of the growth process (Autio & Rannikko, 2016; Brown & Mawson, 2013; Coad et al., 2014).

Financial support is particularly relevant during growth episodes. Firms may need working capital, equipment, inventories, additional staff and resources to expand production, execute larger contracts or enter new markets. Because these costs often arise before the associated revenues are realized, firms with viable growth opportunities may still fail to expand when liquidity or credit constraints become binding. Finance and cash flow are consequently among the barriers frequently reported by HGFs and

firms with high-growth potential, alongside managerial and skill-related constraints (European Investment Bank., 2019; Lee, 2014).

Public financial support, however, is not a homogeneous intervention. Loans provide direct liquidity, guarantees strengthen credit or contractual capacity, and tax exemptions preserve internal resources by reducing eligible tax liabilities. These instruments may therefore address different constraints. Their relevance may also depend on timing: support received before a growth episode may contribute to readiness, whereas support received during the episode may alleviate active scaling bottlenecks. Although previous studies have examined HGF policy, financial constraints and individual support instruments, the joint relationship between instrument type, support timing and high-growth status remains insufficiently understood (Autio & Rannikko, 2016; Brown & Mawson, 2016; Busom et al., 2014; Hottenrott & Richstein, 2020; Lenihan et al., 2025; Ramlogan & Rigby, 2013)

This article examines that relationship using administrative data on certified knowledge-based firms in Iran. Iran provides a useful setting because its formal certification system connects a large population of technology-oriented firms to several public support instruments, including loans, guarantees and tax exemptions. Administrative records also make it possible to distinguish the type and timing of support. The article asks: how are public financial support instruments received before versus during a growth period associated with the probability of attaining high-growth status?

The analysis covers 2,981 firms and identifies HGFs using the Birch index based on real revenue growth between 2020/21 and 2023/24. Firms are classified under the top 5, 10 and 20 percent thresholds of the Birch-index distribution. The empirical models distinguish support received in 2019/20–2020/21 from support received in 2021/22–2022/23 and estimate the relationship between loans, guarantees, tax exemptions and HGF status using logit models with firm-level controls and technology-field effects.

The results show that the relationship between public financial support and high-growth status varies by instrument and timing. Loans received during the growth period have the clearest and most consistent positive association with HGF status, whereas earlier loans do not show the same pattern. Guarantees display weaker and less stable associations, while tax exemptions are not significantly associated with HGF status in the main specifications. Because support allocation was not randomized and the data are observational, these findings are interpreted as conditional associations rather than causal effects.

The article makes three contributions. First, it introduces an instrument–timing perspective into HGF policy research by examining not only whether firms receive support, but which instruments they receive and when. Second, it provides evidence from administrative data covering a large population of certified knowledge-based firms in an emerging-economy policy setting. Third, it contributes to policy design by showing that financial instruments should not be treated as interchangeable: their relevance depends on the alignment between their mechanisms, firms' growth stages and the constraints that become binding during scaling.

The rest of the article proceeds as follows. Section 2 reviews the literature and develops the hypotheses. Section 3 describes the institutional context of public financial support for knowledge-based firms in Iran. Section 4 presents the data, variables and empirical strategy. Section 5 reports the results. Section 6 discusses the findings, contributions and limitations, and Section 7 concludes.

2. Literature Review and Hypothesis Development

2.1. High-growth firms

Firm growth is highly uneven across the population of firms. While many firms remain small, stable or slow-growing over long periods, a relatively small group experiences rapid expansion and accounts for a disproportionate share of employment creation, sales growth, innovation and economic dynamism. These firms are commonly discussed as high-growth firms (HGFs) or gazelles in the entrepreneurship and firm-growth literature. The importance of HGFs lies in their position in the upper tail of the growth distribution: they are empirically rare, yet economically significant. For this reason, HGF research has shifted attention away from average growth and toward the conditions under which exceptional growth episodes emerge. Prior studies show that HGFs matter for job creation and renewal, but also that their growth trajectories are often irregular, heterogeneous and difficult to sustain over time (Birch, 1981; Coad et al., 2014; Henrekson & Johansson, 2010; Moreno & Coad, 2015; OECD, 2010).

2.2. The policy challenge of targeting high-growth firms

The economic importance of HGFs makes them attractive policy targets, but identifying future high-growth firms before rapid growth occurs is difficult. High growth is often temporary, uneven across sectors and weakly persistent over time. Firms that appear promising ex ante may not enter a high-growth trajectory, while firms that eventually experience rapid growth may not have been readily identifiable beforehand. These characteristics limit the reliability of conventional winner-picking strategies and create substantial risks of selection error.

The policy challenge is therefore not simply to identify a fixed group of firms that can be labelled as future HGFs. It is to recognize emerging growth opportunities and respond to the changing constraints firms face as those opportunities develop. This perspective shifts HGF policy away from static firm selection and toward more adaptive approaches that consider firms' capabilities, growth signals and stages of development (Coad et al., 2014; Hamilton & Ng, 2025).

2.3. Growth episodes, trigger points and scaling constraints

A growing stream of research views rapid firm growth as episodic rather than linear. Firms may enter growth episodes when they encounter trigger points such as large contracts, entry into new markets, product commercialization, organizational restructuring, changes in the management team, or access to new resources. These trigger points can open growth opportunities, but they also create pressures that

the firm must absorb. A company entering a growth episode may need to increase production capacity, hire staff, finance inventories, deliver larger orders, manage more complex customer relationships and build managerial systems that were unnecessary at smaller scale. Thus, high growth is not simply a positive outcome; it is also an organizational and financial stress test. Evidence from studies of HGFs and potential HGFs shows that firms in or near periods of high growth frequently report barriers related to finance, cash flow, management skills, recruitment and skill shortages (Brown & Mawson, 2013; Lee, 2014).

2.4. Financial constraints during growth episodes

Finance is especially important during growth episodes because the costs of scaling often arise before the corresponding revenues are fully realized. Firms may need working capital to execute contracts, buy inputs, pay employees, expand capacity or enter new markets. Even when market demand exists, a firm may fail to convert that demand into realized growth if it lacks sufficient liquidity or credit capacity. This issue is particularly relevant for innovative and knowledge-based firms, whose assets may be intangible, whose future revenues are uncertain, and whose financing needs may increase sharply during commercialization and scale-up. At the same time, financial support should not be treated as the only condition for high growth. Rapid expansion also depends on managerial capabilities, market access, organizational routines and sectoral opportunities. The relevant point for HGF policy is therefore more specific: financial support can matter when it is aligned with the bottlenecks that firms face during growth episodes (Brown & Mawson, 2013; European Investment Bank., 2019; Lee, 2014).

2.5. Public support for high-growth firms

A growing policy literature examines whether targeted public interventions can support firms with high-growth potential. These programmes commonly combine financial assistance with selection, monitoring, advisory services and capability-building. Evidence suggests that carefully designed and staged interventions may improve firm performance. For example, Autio and Rannikko's evaluation of a Finnish high-growth entrepreneurship programme found stronger growth among supported firms than among comparable non-participants, using panel data and propensity-score matching.

At the same time, the evidence does not support treating all targeted programmes as equivalent. Programme outcomes depend on how firms are selected, which constraints are addressed, how support is staged and whether the intervention remains aligned with firms' evolving needs. Broad measures of programme participation may therefore conceal important differences in programme design and instrument composition. This suggests that the evaluation of HGF policy should move beyond the question of whether supported firms perform better on average and examine the specific instruments and stages through which support is delivered (Autio & Rannikko, 2016; Brown & Mawson, 2016; Mason & Brown, 2013).

2.6. Heterogeneity of public financial support instruments

Public financial support is not a homogeneous policy instrument. Different tools operate through different mechanisms and may therefore be associated with different firm outcomes. Loans provide financial resources that can be used for working capital, tangible investment, production expansion or market development. Guarantees do not provide liquidity directly, but they can strengthen the firm's ability to obtain credit or participate in contracts that require formal assurance. Tax exemptions and tax credits operate through a different channel: they reduce tax liabilities or preserve internal resources, and their usefulness depends on the firm's taxable income, profitability and capacity to benefit from the tax system. Prior evidence from innovation and SME policy shows that grants, subsidized loans, guarantees and tax incentives can have different implications for R&D investment, tangible investment, employment, revenue and innovation. Treating financial support as a single aggregate variable can therefore conceal important differences in the mechanisms through which policy instruments relate to firm growth (Hottenrott & Richstein, 2020; Testa et al., 2019).

2.7. Loans, guarantees and tax exemptions as distinct mechanisms

The distinction among instruments is particularly important for firms in a growth episode. Loans can directly address liquidity needs and may therefore be especially relevant when firms must finance inventories, expand production or execute contracts before revenues are collected. Guarantees may be useful where the firm's main constraint is contractual or credit credibility rather than immediate cash. They can help firms access loans, obtain advances or participate in larger projects, but their contribution to realized growth depends on whether the guaranteed transaction is converted into sales, capacity or market expansion. Tax exemptions are likely to operate more indirectly. They may improve retained earnings and reduce fiscal pressure, yet they are less suited to solving immediate pre-revenue liquidity constraints. Evidence on credit guarantees and R&D tax incentives supports this distinction: guarantees can relax credit rationing and support sales or employment, while tax-based instruments tend to depend on firms' tax positions, prior R&D engagement and ability to use the incentive effectively (Busom et al., 2014; Ramlogan & Rigby, 2013).

2.8. Timing of support and instrument–timing fit

If high growth is episodic and linked to trigger points, the timing of support becomes theoretically important. Support received before a growth episode may help firms build readiness, develop capabilities or prepare for future expansion. Support received during a growth episode may perform a different function by easing active bottlenecks in liquidity, production, contract execution and market delivery. This distinction suggests that the relationship between public support and HGF status depends not only on whether a firm receives support, or on which instrument it receives, but also on whether the instrument is aligned with the phase of the growth process in which the firm is located. This idea is consistent with recent work on policy instrument sequencing, which shows that the order and timing of policy instruments can shape firm-level outcomes. Yet this sequencing perspective has rarely been applied to HGF formation or to the comparison of loans, guarantees and tax exemptions around a growth episode (Brown & Mawson, 2013; Lenihan et al., 2025).

2.9. Research gap

Existing studies have examined high-growth firm policy, growth constraints and the effects of individual support instruments. However, they commonly evaluate programmes as broad interventions, focus on average firm-growth or innovation outcomes, or examine instrument type without considering its timing relative to the growth process. The joint relationship between instrument type, support timing and high-growth status therefore remains insufficiently understood. This study addresses this gap by comparing loans, guarantees and tax exemptions received before and during the observed growth period.

2.10. Hypotheses

Based on the preceding discussion, the study develops three hypotheses. First, because public financial instruments operate through different mechanisms, their association with HGF status is expected to vary across loans, guarantees and tax exemptions.

H1. The association between public financial support and high-growth status differs across loans, guarantees and tax exemptions.

Second, because rapid growth creates active scaling pressures, support received during the growth period is expected to be more strongly associated with HGF status than support received before the growth period.

H2. Public financial support received during the growth period is more strongly associated with high-growth status than public financial support received before the growth period.

Third, because loans provide direct liquidity that can be used to finance working capital, capacity expansion and contract execution, loans received during the growth period are expected to show the strongest and most stable positive association with HGF status compared with guarantees and tax exemptions.

H3. Loans received during the growth period have the strongest and most stable positive association with high-growth status among the financial support instruments examined.

3. Institutional Context: Public Financial Support for Knowledge-Based Firms in Iran

Iran provides a useful setting for examining the relationship between public financial support and high-growth firm status because it has developed a formal system for identifying and supporting knowledge-based firms. The legal foundation of this system is the Law for Supporting Knowledge-Based Companies and Institutions and the Commercialization of Innovations and Inventions (Majlis Research Center, 2010). The framework is administered primarily by the Vice Presidency for Science, Technology and Knowledge-Based Economy, which evaluates and certifies eligible firms, and by the Iran National

Innovation Fund, which serves as the main specialized public financing institution for certified knowledge-based firms.

Certification is based on the technological characteristics of firms' products and services. Once certified, firms may become eligible for financial, tax, customs, regulatory and capability-building support. This certification-based structure creates an identifiable population of technology-oriented firms and links firm characteristics and performance data to administrative records on support receipt. At the time of data collection, the administrative dataset contained 10,126 active certified knowledge-based firms, although the size of the certified population changes over time as new firms enter the system and others lose or do not renew their certification.

The Iran National Innovation Fund provides or facilitates several forms of financial and quasi-financial support, including loans, guarantees, leasing arrangements and interest-rate subsidies (Iran National Innovation Fund, n.d.-a). Access to these instruments is not automatic. Firms submit applications that are evaluated according to the requirements of the relevant support programme before approval, contracting and disbursement. This application and assessment process is important for interpreting the empirical results because recipient firms may differ systematically from non-recipient firms in their financial needs, administrative capacity, creditworthiness or growth prospects.

This study focuses on three instruments: loans, guarantees and tax exemptions. Loans provide firms with financial resources that may be used for purposes such as working capital, production expansion, commercialization and contract execution. Guarantee support operates more indirectly by strengthening firms' ability to obtain credit or participate in contracts that require formal financial assurances. The Fund's guarantee services include support for bank-issued guarantees and reductions in the cash-deposit or fee requirements imposed on eligible firms (Iran National Innovation Fund, n.d.-b). The Iran National Innovation Fund also publishes annual and multi-year performance reports (Fig. 1), which can be used to document the expansion of financial services over time.

Tax exemptions are administered through a different institutional channel. Under the Law for Supporting Knowledge-Based Companies and Institutions, eligible firms may receive exemptions on income generated from approved knowledge-based products and services. The exemption does not apply automatically to all firm income and remains conditional on both the eligibility of the relevant products or services and the firm's continued knowledge-based certification (Vice Presidency for Science, Technology and Knowledge-Based Economy, 2023).

The combination of a formally certified firm population, multiple support instruments and administrative information on the timing and amount of support makes the Iranian policy system suitable for the present analysis. It allows the study to distinguish between loans, guarantees and tax exemptions and to compare support received in the period before or at the beginning of the growth window with support received during the growth window.

4. Data and Empirical Strategy

4.1. Data sources and sample construction

The analysis uses administrative firm-level data obtained from the Iran National Innovation Fund and complementary records from the Vice Presidency for Science, Technology and Knowledge-Based Economy. The dataset contains firm identifiers, annual revenue, technology field, establishment and certification dates, and records of financial and tax-related support. The original records follow Iran's Solar Hijri calendar; throughout the article, years are reported using Gregorian-equivalent split-year notation. For example, Solar Hijri year 1399 is reported as 2020/21.

The initial dataset contained 10,126 active certified knowledge-based firms. The estimation sample excludes firms established in or certified after the baseline year, non-commercial ecosystem organizations, firms without valid revenue data for 2020/21 and 2023/24, and firms with incomplete control-variable information. As shown in Table 1, these restrictions result in a final sample of 2,981 firms.

Because annual records were incomplete for some firms and support variables were not consistently available for all firm-year observations, the data were organized as a cross-sectional firm-level dataset. Each firm therefore appears once, with growth, support and baseline characteristics measured at the firm level.

Table 1
Construction of the final estimation sample

Step	Sample restriction	Firms removed	Firms remaining
1	active certified knowledge-based firms in the dataset	----------	10126
2	Exclude firms established in 2020/21 or later	2295	7831
3	Exclude firms certified as knowledge-based after 2020/21	2939	4892
4	Exclude non-commercial ecosystem-related organizations	52	4840
5	Exclude firms without valid financial data in 2020/21 and 2023/24	1771	3069
6	Exclude firms with incomplete control-variable information	88	2981

Although the original data contain information for multiple years, the quality and continuity of the annual records were not sufficient for a full panel-data design. Some firms had incomplete annual performance records, and some support variables were not consistently recorded across all firm-year observations. The data were therefore reorganized into a cross-sectional firm-level dataset in which each firm appears once, with growth, support and baseline characteristics measured at the firm level. This structure does not allow the analysis to exploit within-firm changes over time.

4.2. Measuring high-growth status

The dependent variable indicates whether a firm is classified as a high-growth firm. Consistent with the Eurostat–OECD approach, high growth can be measured using employment or turnover-based indicators. Because reliable employment data were not available for the full sample, this study uses real revenue growth between 2020/21 and 2023/24 (OECD, 2007). Revenue and all other monetary variables were deflated using the consumer price index published by the Statistical Center of Iran, with 2021/22 as the CPI base year, and expressed in constant 2023/24 prices (Statistical Center of Iran, 2025).

High-growth firms are identified using the Birch index, which combines absolute and relative growth and reduces the size bias associated with using either measure alone (Birch, 1987; Coad et al., 2014).

$$birch\ index\ (BI) = (x_t - x_{t-3}) \times \left(\frac{x_t}{x_{t-3}}\right)$$

$$HGF_{5\%} = 1\ if\ BI_i \geq\ P_{95}\ (BI)$$

$$HGF_{10\%} = 1\ if\ BI_i \geq\ P_{90}\ (BI)$$

$$HGF_{20\%} = 1\ if\ BI_i \geq\ P_{80}\ (BI)$$

Firms are ranked according to their Birch-index values, and three binary dependent variables identify firms in the top 5, 10 and 20 percent of the distribution. These thresholds allow the analysis to assess whether the findings are concentrated among the most exceptional growth cases or remain visible under broader definitions of high growth.

4.3. Public financial support variables

The main explanatory variables capture three forms of public financial support: loans, guarantees and tax exemptions. For loans and guarantees, two alternative measures are constructed. The amount-based variables are defined as $\ln(1 + amount)$, where monetary values are expressed in constant 2023/24 prices. Adding one retains non-recipient firms, whose support amount equals zero, while the logarithmic transformation reduces the influence of the highly skewed distribution of support amounts.

The binary variables equal one if the firm received the relevant instrument at least once during the period and zero otherwise. The two specifications therefore compare the association of support amounts with the association of receiving support irrespective of its amount. Tax exemptions are measured only as binary indicators because reliable and comparable monetary values of the tax benefits were not available.

For each instrument, support is divided into two periods. The early period covers 2019/20–2020/21 and represents support received before or at the beginning of the growth window. The later period covers 2021/22–2022/23 and represents support received during the growth window but before the final outcome year.

4.4. Control variables

The models include controls for baseline firm size, organizational maturity, prior exposure to public support and sectoral heterogeneity. Baseline real revenue in 2020/21 enters the models in logarithmic form. Firm age is measured from the year of establishment, while knowledge-based age is measured as the time elapsed since the firm received knowledge-based certification.

Prior exposure to the support system is controlled for using the logged real amounts of loans and guarantees received before 2019/20. Technology-field indicators are also included to account for differences in market conditions, capital requirements and commercialization patterns across sectors.

4.5. Empirical model

Because the dependent variable is binary, the empirical analysis uses logistic regression. Let p_{ik} denote the probability that firm i is classified as a high-growth firm under Birch threshold k, where k represents the top 5, 10, or 20 percent of the Birch-index distribution. The model is specified as follows:

$$\ln\left(\frac{p_{ik}}{1-p_{ik}}\right) = \alpha_k + \beta_{1k} Loan_{i,2019/20-2020/21} + \beta_{2k} Loan_{i,2021/22-2022/23} + \beta_{3k} Guarantee_{i,2019/20-2020/21} + \beta_{4k} Guarantee_{i,2021/22-2022/23} + \beta_{5k} Tax_{i,2019/20-2020/21} + \beta_{6k} Tax_{i,2021/22-2022/23} + \gamma'_k X_i + \sum_{f=1}^{F-1} \delta_{fk} Field_{if}$$

In this specification $p_{ik} = \Pr\left(HGF_{ik} = 1\right)$, where HGF_{ik} equals one if firm i is classified as a high-growth firm under threshold k, and zero otherwise. The loan and guarantee variables represent support received in 2019/20–2020/21 and 2021/22–2022/23, respectively. The tax-exemption variables are binary indicators showing whether the firm benefited from a tax exemption during each period.

X_i is a vector of firm-level control variables, including logged real revenue in 2020/21, firm age, knowledge-based age, and the logged real amounts of loans and guarantees received before 2019/20. $Field_{if}$ represents technology-field indicators, with one technology field omitted as the reference category. Separate models are estimated for the top 5, 10, and 20 percent Birch-index thresholds.

The same general specification is estimated using two alternative measures of the main loan and guarantee variables. In the amount-based specifications, loans and guarantees received in 2019/20–2020/21 and 2021/22–2022/23 are measured as $\ln(1 + real\ amount)$. In the binary specifications, these variables equal one if the firm received the relevant support instrument at least once during the period and zero otherwise. Tax exemptions remain binary in both specifications. All control variables, including the logged real amounts of loans and guarantees received before 2019/20, remain unchanged across the two sets of models.

The models estimate conditional associations rather than causal effects. Public financial support was not randomly assigned, and recipient firms may differ from non-recipient firms in both observable and

unobservable characteristics, including managerial quality, market opportunities, creditworthiness and prior relationships with the support system. In addition, support received during the growth window may be related to growth already underway, creating a potential reverse-causality concern. The included firm-level controls and technology-field effects reduce observable heterogeneity but cannot eliminate selection bias, omitted-variable bias or reverse causality. The estimated coefficients should therefore be interpreted as conditional associations between instrument type, support timing and high-growth status.

4.6. Interpretation of coefficients and marginal effects

Logit coefficients are not directly interpretable as changes in probability because they are expressed in log-odds units. The main regression tables therefore report the coefficient estimates from the logit models, while marginal effects are used as a supplementary aid for substantive interpretation. Where reported, these marginal effects are average marginal effects computed after the logit estimations. They indicate the average change in the predicted probability of being classified as a high-growth firm associated with a change in the explanatory variable, conditional on the covariates included in the model. For binary variables, the marginal effect is interpreted as the average discrete change in predicted probability when the variable changes from 0 to 1.

4.7. Robustness checks

To assess the stability of the findings, the analysis uses three HGF thresholds: the top 5, 10 and 20 percent of the Birch-index distribution. This allows us to examine whether the results are specific to the most extreme high-growth firms or remain consistent under broader definitions. In addition, the two alternative support specifications—logged support amounts and binary support indicators—allow us to compare the association of support intensity with the association of access to support. As an additional robustness check, the main specifications are re-estimated using probit models. The probit estimations use the same dependent-variable thresholds, support variables, controls and technology-field effects as the baseline logit models. This check examines whether the substantive findings depend on the choice of the logit link function.

5. Results

5.1. Descriptive patterns

Of the 2,981 firms in the estimation sample, 150 are classified as high-growth firms under the top-5-percent Birch threshold, 299 under the top-10-percent threshold, and 597 under the top-20-percent threshold. These definitions distinguish the most exceptional growth cases from broader high-growth classifications.

Table 2 reports support receipt by instrument and period. Loans were the most widely used instrument, received by 41.8 percent of firms in 2019/20–2020/21 and 45.0 percent in 2021/22–2022/23. Tax exemptions were received by 31.4 and 36.2 percent of firms, respectively, while guarantees were substantially less common, covering 8.5 and 10.4 percent of the sample.

Table 2
Number of firms receiving each type of public financial support in each period, with percentages calculated relative to the final estimation sample of 2,981 firms

Support instrument	2019/20-2020/21	2021/22-2022/23
Loans	1,247 (41.8%)	1,342 (45%)
Guarantees	255 (8.5%)	311 (10.4%)
Tax exemptions	936 (31.4%)	1,078 (36.2%)

Table 2 summarizes the distribution of public financial support across the final estimation sample by instrument and period. Loans were substantially more common than guarantees in both periods, while tax exemptions were also recorded for a considerable number of firms. These descriptive patterns suggest that the three instruments differed not only in their mechanisms, but also in their degree of diffusion across knowledge-based firms.

5.2. Main amount-based results

Table 3 presents the main logit estimates. The results show a clear difference between loans received before or at the beginning of the growth window and loans received during the growth window. Loans received in 2019/20–2020/21 are not significantly associated with high-growth status under any of the three Birch-index thresholds. By contrast, loans received in 2021/22–2022/23 are positively associated with high-growth status across all three definitions. This association is statistically significant and remains visible under both stricter and broader HGF thresholds.

Table 3
Logit estimates of high-growth status by support specification and HGF threshold

Variables	logged Variables			Dummy Variables		
	Birch 5%	Birch 10%	Birch 20%	Birch 5%	Birch 10%	Birch 20%
Loans, 2019/20–2020/21	-0.0034 (0.0069)	-0.0054 (0.0059)	-0.0015 (0.0038)	-0.1602 (0.1600)	-0.2197 (0.1429)	-0.0879 (0.0901)
Loans, 2021/22–2022/23	0.0078* (0.0040)	0.0119*** (0.0038)	0.0090*** (0.0033)	0.1468 (0.1034)	0.2734*** (0.0868)	0.1854** (0.0788)
Guarantees, 2019/20–2020/21	-0.0021 (0.0075)	0.0090 (0.0093)	0.0063 (0.0075)	-0.1032 (0.1776)	0.1823 (0.2309)	0.1176 (0.1841)
Guarantees, 2021/22–2022/23	0.0194** (0.0084)	0.0030 (0.0093)	0.0093* (0.0052)	0.4252** (0.2017)	0.0321 (0.2380)	0.2037 (0.2022/23)
Tax exemptions, 2019/20–2020/21	0.1108 (0.1426)	-0.0719 (0.1018)	0.0484 (0.0701)	0.1251 (0.1410)	-0.0597 (0.1004)	0.0567 (0.0691)
Tax exemptions, 2021/22–2022/23	0.1863 (0.1418)	0.1314 (0.1427)	0.0630 (0.0736)	0.2032 (0.1426)	0.1459 (0.1433)	0.0754 (0.0734)
Pre-2019/20 loans	-0.0269*** (0.0050)	-0.0154*** (0.0047)	-0.0045 (0.0029)	-0.0257*** (0.0050)	-0.0144*** (0.0046)	-0.0037 (0.0028)
Pre-2019/20 guarantees	-0.0408 (0.0596)	0.0035 (0.0211)	0.0215** (0.0098)	-0.0391 (0.0593)	0.0049 (0.0206)	0.0226** (0.0095)
Revenue in 2020/21	0.1486*** (0.0375)	0.2640*** (0.0346)	0.2255*** (0.0175)	0.1562*** (0.0375)	0.2702*** (0.0341)	0.2309*** (0.0176)
Firm age	-0.0046 (0.0148)	-0.0059 (0.0113)	-0.0088 (0.0058)	-0.0046 (0.0148)	-0.0058 (0.0113)	-0.0088 (0.0058)
Knowledge-based age	0.0525** (0.0203)	-0.0292 (0.0266)	-0.0641*** (0.0206)	0.0547*** (0.0193)	-0.0256 (0.0263)	-0.0624*** (0.0206)
_cons	-8.3731*** (1.4998)	-8.82675*** (1.0375)	-6.67753*** (0.3558)	-8.5404*** (1.5029)	-8.9735*** (1.0328)	-6.7978*** (0.3582)
Observations	2972	2981	2981	2972	2981	2981
legend: * p < 0.1; ** p < 0.05;*** p < 0.01						

Variables	logged Variables			Dummy Variables		
	Birch 5%	Birch 10%	Birch 20%	Birch 5%	Birch 10%	Birch 20%
Pseudo R-squared	0.0537	0.0752	0.0635	0.0525	0.0749	0.0624
legend: * p < 0.1; ** p < 0.05;*** p < 0.01						

The results for guarantees are less stable. Guarantees received in 2019/20–2020/21 are not significantly associated with high-growth status. Guarantees received in 2021/22–2022/23 show a positive association in some models, but the pattern is weaker and less consistent than for loans.

Tax exemptions do not show a statistically significant association with high-growth status in the amount-based models. This holds for both time periods and across the three HGF thresholds. This does not imply that tax exemptions are irrelevant for all firm outcomes. Rather, within the outcome and period studied here, tax exemptions are not systematically associated with the probability of being classified as a high-growth firm.

5.3. Binary support models

The binary specifications reported in the final three columns of Table 3 produce a broadly similar pattern. Receiving loans in 2019/20–2020/21 is not significantly associated with HGF status under any threshold. Receiving loans in 2021/22–2022/23 is positively associated with HGF status across the three thresholds, although the coefficient is statistically significant only under the top-10- and top-20-percent definitions.

Early-period guarantees remain statistically insignificant. Later-period guarantees are positively and significantly associated with HGF status only under the top-5-percent threshold and are not significant under the broader definitions.

Tax exemptions remain statistically insignificant in both periods and across all three thresholds. Overall, the binary specifications confirm that later-period loans display a more consistent positive association with HGF status than the other instruments.

5.4. Substantive interpretation

Table 4 reports predicted probabilities of HGF status at selected levels of loans and guarantees received during the growth period. The table focuses on these two amount-based instruments because they provide a clearer way to interpret the substantive magnitude of the instrument–timing relationship.

Table 4
Predicted probabilities of HGF status at selected support levels

Support instrument	Support level	Birch 5%	Birch 10%	Birch 20%
Loans, 2021/22–2022/23	0	0.0445	0.0869	0.1819
Loans, 2021/22–2022/23	1 billion rials	0.0517	0.1073	0.2094
Loans, 2021/22–2022/23	10 billion rials	0.0526	0.1098	0.2126
Loans, 2021/22–2022/23	100 billion rials	0.0535	0.1123	0.2159
Loans, 2021/22–2022/23	1,000 billion rials	0.0544	0.1149	0.2192
Guarantees, 2021/22–2022/23	0	0.0455	—	0.1925
Guarantees, 2021/22–2022/23	1 billion rials	0.0658	—	0.2222
Guarantees, 2021/22–2022/23	10 billion rials	0.0686	—	0.2257
Guarantees, 2021/22–2022/23	100 billion rials	0.0714	—	0.2292
Guarantees, 2021/22–2022/23	1,000 billion rials	0.0743	—	0.2327

The predicted probabilities show that higher loan amounts in 2021/22–2022/23 are associated with a higher probability of being classified as an HGF. This pattern is most visible under the Birch 20 percent definition: moving from no loan support to 1,000 billion rials in loans is associated with an increase in the predicted probability of HGF status from 18.19 percent to 21.92 percent. This corresponds to a 3.73 percentage-point increase, or roughly a 21 percent relative increase. The size of the change is moderate, but the direction is consistent with the main logit results: loans received during the growth period are positively associated with high-growth status.

For guarantees, the strongest relative change appears under the Birch 5 percent definition. The predicted probability rises from 4.55 percent with no guarantee support to 7.43 percent at 1,000 billion rials, equivalent to a 2.88 percentage-point increase, or about a 63 percent relative increase. However, this increase starts from a low baseline and the guarantee results are less consistently supported across the main coefficient estimates. Therefore, the guarantee pattern should be interpreted more cautiously than the loan pattern.

Overall, Table 4 reinforces the main finding that financial support received during the growth period is associated with a higher predicted probability of HGF status, with the clearest and most stable pattern observed for loans. These predicted probabilities should be interpreted as conditional associations rather than causal effects.

5.5. Control variables and sectoral differences

ogged baseline revenue in 2020/21 is positively and significantly associated with HGF status across all specifications. Firm age is not statistically significant, while knowledge-based age shows mixed

associations across the three thresholds.

The logged amount of loans received before 2019/20 is negatively associated with HGF status under the top-5- and top-10-percent definitions but is not significant under the top-20-percent definition. Prior guarantees show no consistent pattern across the models.

Technology-field indicators are included in all specifications to account for sectoral heterogeneity. To maintain the focus of the main results on the support variables, the detailed technology-field coefficients are reported in Appendix Table A1.

Overall, the findings are consistent with the proposed instrument–timing argument. Loans received during the growth period show the most consistent positive association with HGF status, while guarantees display a less stable pattern and tax exemptions remain insignificant across specifications.

5.7. Probit robustness check

As a robustness check, the main specifications were re-estimated using probit models with the same HGF thresholds, support variables, controls and technology-field indicators. The results reported in Appendix Table A2 are substantively consistent with the baseline logit estimates: later-period loans retain the clearest and most stable positive association with HGF status, while the results for earlier loans, guarantees and tax exemptions remain weaker or less consistent.

6. Discussion

6.1. Interpreting the main findings

The findings indicate that public financial support should not be treated as a homogeneous policy intervention. The strongest and most stable association is observed for loans received during the growth period. Earlier loans do not show the same pattern, guarantees display weaker and less stable associations, and tax exemptions are not significantly associated with high-growth status across the main specifications.

These results support the instrument–timing fit argument developed in the literature review. The association between financial support and high-growth status depends jointly on the mechanism of the instrument and the timing of support. Loans appear most relevant when they coincide with the active growth period, when firms may face immediate liquidity needs related to working capital, production expansion, contract execution and market delivery. This pattern is consistent with the view that rapid growth is episodic and often linked to trigger points that generate both opportunities and resource pressures (Brown & Mawson, 2013). It also resonates with evidence that firms in or near high-growth periods face financial and cash-flow constraints alongside managerial and organizational barriers (Lee, 2014).

6.2. Contribution to high-growth firm policy research

The findings contribute to the literature on high-growth firm policy in three ways. First, the study shifts attention from the broad question of whether public support matters to the more specific question of which instrument is associated with high-growth outcomes and when. Given the difficulty of identifying future HGFs ex ante, policy analysis should focus not only on firm selection but also on the match between instrument design and the firm's position in the growth process (Coad et al., 2014; Hamilton & Ng, 2025).

Second, the study contributes to research on targeted support for HGFs. Prior research shows that selective and staged programmes can be associated with stronger firm growth when carefully designed, while also warning that targeted support rests on demanding assumptions about selection, timing and firm needs (Autio & Rannikko, 2016; Brown & Mawson, 2016). The present findings show that programme participation alone may conceal important differences among the instruments contained within the same policy system.

Third, the paper extends the discussion of instrument heterogeneity in innovation and SME policy. Existing research shows that loans, grants, guarantees and tax incentives differ in their mechanisms and outcomes (Busom et al., 2014; Hottenrott & Richstein, 2020; Ramlogan & Rigby, 2013) The present study brings this insight into HGF research by showing that loans, guarantees and tax exemptions should not be treated as interchangeable forms of financial support.

6.3. Timing, sequencing and growth episodes

The timing result is central to the paper's contribution. Support received during the growth period is more strongly associated with high-growth status than support received earlier, especially in the case of loans. This does not imply that earlier support is unimportant. Earlier support may help firms build technological capabilities, improve readiness or prepare for later expansion. However, the empirical results suggest that the support most closely associated with observed high growth is support received closer to the active growth episode.

This finding connects HGF policy with the emerging discussion of policy instrument sequencing. Recent work on R&D policy suggests that the order and timing of instruments can shape firm-level outcomes (Lenihan et al., 2025). The present study extends this logic to high-growth firm formation. If growth episodes create temporary but intense bottlenecks, the relevance of a policy instrument depends on whether it reaches the firm when the bottleneck is active. This is especially important for liquidity-based instruments. A loan received during a period of expanding demand or contract execution may be more closely aligned with the firm's immediate growth needs than the same instrument received earlier.

6.4. Interpreting the weaker findings for guarantees and tax exemptions

The weaker and less stable results for guarantees are consistent with the indirect mechanism of this instrument. Guarantees can improve a firm's credit or contractual capacity, but they do not provide liquidity in the same direct way as loans. Their association with growth may depend on whether the

guaranteed transaction becomes a contract, whether the contract is executed successfully, and whether execution translates into revenue growth within the observation period. For this reason, guarantees may matter more for project-based, contract-intensive or capital-intensive firms, a possibility that should be examined in future sector-specific research.

The insignificant results for tax exemptions should also be interpreted through the mechanism of the instrument. Tax exemptions reduce tax liabilities or preserve internal resources, but their usefulness depends on the existence of taxable income and eligible knowledge-based activities. Firms in rapid growth episodes may face immediate financing needs before taxable profits are realized. As a result, tax exemptions may be less closely connected to short-term high-growth status than instruments that directly relax liquidity constraints. This finding does not imply that tax exemptions are ineffective for all outcomes. They may still matter for R&D investment, profitability, survival or longer-term capability accumulation. The present evidence is limited to HGF status within the observed period.

6.5. Policy implications

The findings should not be interpreted as evidence that governments should simply increase lending to all firms. A more cautious implication is that public support should be matched to firms' growth stages and binding constraints. Policymakers should ask which firms are entering or approaching a growth episode, which bottlenecks they face, and which instrument is best suited to that bottleneck.

For firms facing immediate liquidity constraints, loans or working-capital instruments may be more appropriate. For firms whose main constraint is contractual credibility or access to bank finance, guarantees may be more relevant. For firms with stable profits and eligible knowledge-based revenues, tax exemptions may support internal resource accumulation, but they should not be expected to function as the main tool for short-term scaling. A more sophisticated HGF policy would therefore combine screening of growth readiness with diagnosis of firm-specific bottlenecks and staged deployment of instruments.

This perspective also reduces the risk of simplistic winner-picking. Since high growth is difficult to predict and often temporary, policy should not rely solely on ex ante identification of future HGFs. Instead, policy systems can monitor signals of growth episodes—such as large contracts, market expansion, production bottlenecks or rapid revenue acceleration—and align financial support with the needs generated by those episodes. This would move HGF support from general subsidy allocation toward adaptive, stage-sensitive policy design.

6.6. Limitations and future research

This study has several limitations. First, the observational and cross-sectional design does not permit causal identification or the analysis of within-firm changes over time. Public financial support was not randomly assigned, and unobserved differences between recipient and non-recipient firms may influence both support receipt and high-growth status. In addition, support received during the growth period may be related to growth already underway. Although the models account for observable firm characteristics,

prior support and technology-field differences, they cannot fully eliminate selection bias or reverse causality. Future research could strengthen causal inference by using more complete longitudinal data, matching methods, difference-in-differences designs or quasi-experimental variation generated by programme eligibility rules.

Second, high-growth status is measured using real revenue growth between 2020/21 and 2023/24. Although revenue captures an important dimension of market expansion, it does not reflect employment growth, productivity or the persistence of growth beyond the observation period. Because high growth may be temporary, future research should compare alternative definitions of HGFs and examine whether supported firms sustain their growth after the initial growth episode.

Third, the analysis focuses on three financial instruments—loans, guarantees and tax exemptions—and does not examine non-financial support such as mentoring, management training, networking or market-access assistance. Financial and non-financial interventions may operate as complements, and their relevance may vary across technology fields and firm characteristics. Future studies should therefore examine how different instruments can be combined and sequenced to address the heterogeneous constraints firms face before and during growth episodes.

7. Conclusion

This article examined how different public financial support instruments are associated with the formation of high-growth firms among knowledge-based firms in Iran. Building on the literature on high-growth firms, financial constraints and targeted public support, the study argued that public financial support should be analysed through an instrument–timing lens. The central question was not whether support matters in general, but whether different instruments received before or during a growth period are differently associated with high-growth status.

Using administrative data on 2,981 knowledge-based firms, the study measured high-growth status through the Birch index based on real revenue growth between 2020/21 and 2023/24. Firms were classified as high-growth under three thresholds: the top 5, 10 and 20 percent of the Birch-index distribution. The empirical models distinguished among loans, guarantees and tax exemptions, and further separated support received in 2019/20–2020/21 from support received in 2021/22–2022/23.

The findings show that the association between public financial support and high-growth status is not uniform. Loans received during the growth period show the strongest and most stable positive association with HGF status. Loans received earlier do not show the same pattern. Guarantees display a weaker and less consistent association, while tax exemptions are not significantly associated with high-growth status in the main specifications. These results support the view that both the type and timing of support matter.

The article contributes to high-growth firm policy research by showing that support instruments should not be treated as interchangeable. Liquidity-providing instruments appear more closely aligned with the

active scaling needs of firms during growth episodes, while guarantees and tax exemptions operate through more indirect mechanisms. For policy design, this implies that support should be matched to the firm's growth stage and binding constraint rather than allocated as a generic package. Future research using longitudinal or quasi-experimental designs could more clearly identify the causal effects and sequencing of public financial support.

Declarations

Author Contribution

Baghban is the student who worked with data and analysed them while E.S and A.B. were his supervisores working jointly on the topic selection, theoretical framework, methodology and analysing results. A.B. spent more time on writing the draft and E.S. and Baghban worked on reviewing the manuscript.

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Appendix

Appendix Table A1

Predicted probabilities of high-growth status by technology field (in logged variables model)

Technology field	Birch 5%	Birch 10%	Birch 20%
Biotechnology, agriculture, and food industries	0.0119 (0.0130)	0.1009*** (0.0255)	0.2463*** (0.0526)
Pharmaceuticals and advanced products for diagnosis and treatment	0.0878*** (0.0211)	0.1701*** (0.0251)	0.2889*** (0.0286)
Advanced materials and products based on chemical technologies	0.0703*** (0.0172)	0.1224*** (0.0221)	0.2575*** (0.0219)
Advanced machinery and equipment	0.0455*** (0.0076)	0.0846*** (0.0124)	0.1934*** (0.0094)
Medical devices, supplies, and equipment	0.0082 (0.0100)	0.0420** (0.0189)	0.1443*** (0.0237)
Electrical and electronics, photonics, telecommunications, and automated systems	0.0413*** (0.0053)	0.0899*** (0.0083)	0.1803*** (0.0103)
Information and communication technology and computer software	0.0510*** (0.0043)	0.1031*** (0.0054)	0.1707*** (0.0076)
Commercialization services	0.0143*** (0.0026)	0.0304*** (0.0060)	0.1486*** (0.0319)
Cultural industries, creative industries, and humanities and social sciences	-	0.0945 (0.1009)	0.0970 (0.1074)

Appendix Table A2

Probit robustness estimates of high-growth status by support specification and HGF threshold

Variables	logged Variables			Dummy variables		
	Birch 5%	Birch 10%	Birch 20%	Birch 5%	Birch 10%	Birch 20%
Loans, 2019/20–2020/21	-0.0017	-0.0031	-0.0010	-0.0811	-0.1241*	-0.0553
	(0.0032)	(0.0031)	(0.0022)	(0.0740)	(0.0746)	(0.0518)
Loans, 2021/22–2022/23	0.0044**	0.0069***	0.0055***	0.0843*	0.1570***	0.1139**
	(0.0019)	(0.0020)	(0.0019)	(0.0489)	(0.0463)	(0.0440)
Guarantees, 2019/20–2020/21	-0.0005	0.0060	0.0041	-0.0374	0.1229	0.0779
	(0.0036)	(0.0049)	(0.0043)	(0.0859)	(0.1201)	(0.1056)
Guarantees, 2021/22–2022/23	0.0105***	0.0022	0.0059*	0.2338**	0.0305	0.1292
	(0.0038)	(0.0048)	(0.0032)	(0.0921)	(0.1233)	(0.0850)
Tax exemptions, 2019/20–2020/21	0.0741	-0.0128	0.0368	0.0801	-0.0070	0.0419
	(0.0649)	(0.0531)	(0.0399)	(0.0644)	(0.0527)	(0.0393)
Tax exemptions, 2021/22–2022/23	0.0688	0.0515	0.0337	0.0764	0.0596	0.0409
	(0.0678)	(0.0709)	(0.0433)	(0.0683)	(0.0712)	(0.0432)
Pre-2019/20 loans	-0.0126***	-0.0078***	-0.0024	-0.0120***	-0.0072***	-0.0020
	(0.0022)	(0.0023)	(0.0016)	(0.0022)	(0.0023)	(0.0016)
Pre-2019/20 guarantees	-0.0193	0.0024	0.0129**	-0.0182	0.0031	0.0136**
	(0.0242)	(0.0100)	(0.0056)	(0.0240)	(0.0097)	(0.0054)
Revenue in 2020/21	0.0453***	0.1032***	0.1114***	0.0484***	0.1063***	0.1143***
	(0.0118)	(0.0141)	(0.0096)	(0.0118)	(0.0140)	(0.0097)
Firm age	-0.0008	-0.0006	-0.0040	-0.0007	-0.0006	-0.0039
	(0.0074)	(0.0061)	(0.0033)	(0.0074)	(0.0061)	(0.0033)
Knowledge-based age	0.0243***	-0.0182	-0.0405***	0.0250***	-0.0164	-0.0396***
	(0.0093)	(0.0132)	(0.0119)	(0.0088)	(0.0131)	(0.0119)
Constant	-3.4631***	-3.8471***	-3.4031***	-3.5262***	-3.9169***	-3.4650***
	(0.5343)	(0.4354)	(0.1844)	(0.5352)	(0.4349)	(0.1868)
Observations	2,972	2,981	2,981	2,972	2,981	2,981
Pseudo R-squared	0.0492	0.0657	0.0598	0.0476	0.0651	0.0585

Figures

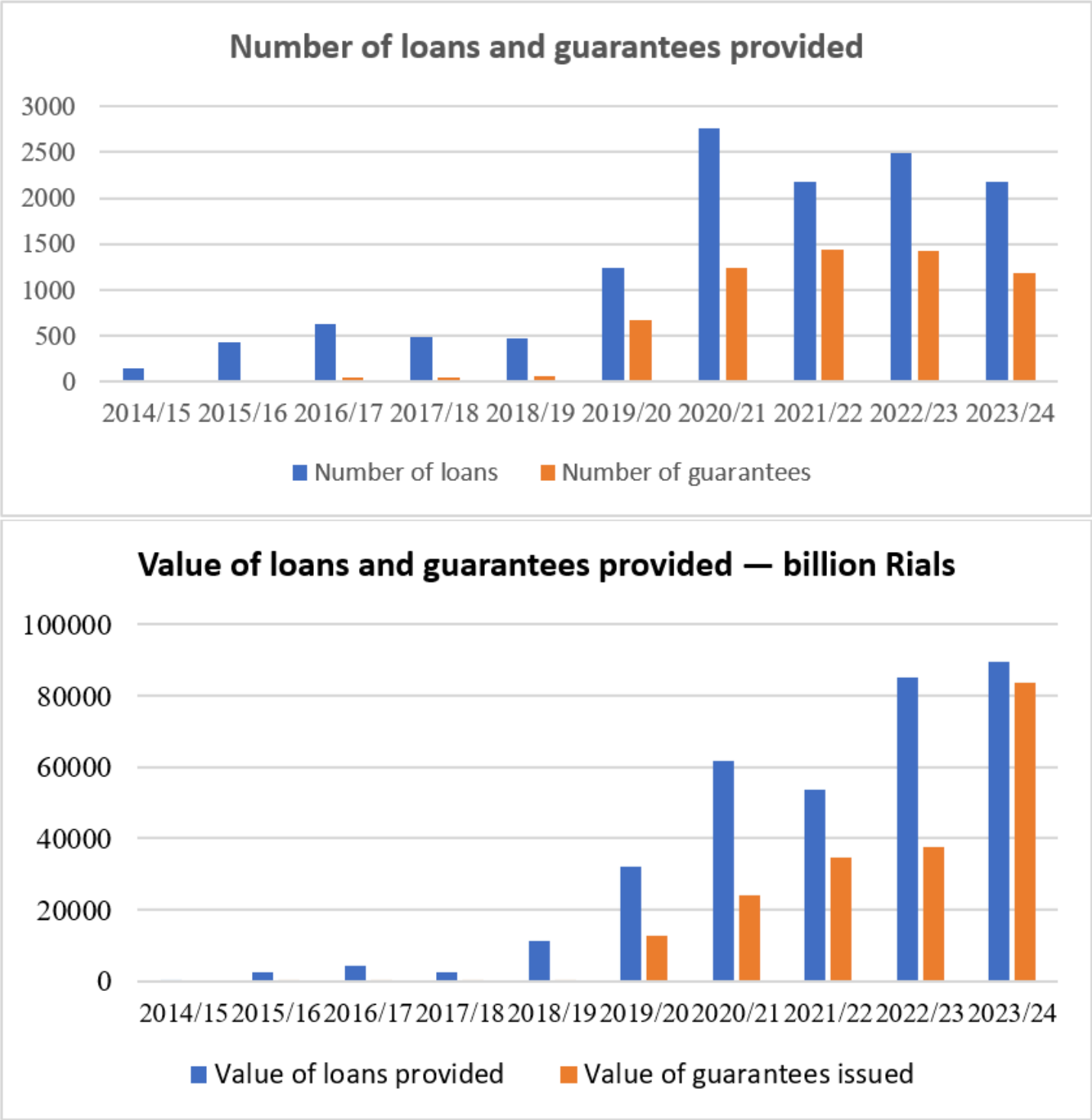

Figure 1

Number and value of loans and guarantees provided by the Iran National Innovation Fund, by Iranian calendar year(Iran National Innovation Fund, n.d.-c)