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**Growth Dynamics of High-Tech Start-ups in Singapore
A Longitudinal Study**

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**Executive
Summary**

Prepared by:

**Wong Poh Kam
Ho Yuen Ping
Ng Su Juan Crystal**



Executive Summary

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This report presents findings from a study on high-tech start-ups in Singapore conducted by the NUS Entrepreneurship Centre (NEC) with funding support from the National Research Foundation (NRF). The study was conducted over two years from 2015 to 2017, and serves as an extension to an earlier research project by NEC which examined the state of high-tech start-ups (HTSUs) in Singapore during 2009/2010. This current study consists of three components:

1. To examine the group of start-ups surveyed during the earlier project back in 2010, and trace the progress they made in the intervening 5 years, from 2010 till present.
2. To analyse the cohort of high-tech start-ups founded after 2010, in terms of growth dynamics, challenges faced and founder characteristics
3. To compare and contrast firm dynamism trends in Singapore and benchmark them against selected OECD countries.

In this study, high tech start-ups are defined as Singapore-incorporated firms with individual ownership of more than 50%, employing at least 1 worker and classified as belonging to sectors with high R&D expenditure and employment intensity, an adaptation of the criteria suggested by Buchart (1987). The study does not impose an age restriction in defining startups, so as to allow for comparisons to be made between start-ups in different age groups. Start-ups founded prior to 2010 are grouped as 'mature' start-ups while those founded 2010 and after are known as 'young' start-ups in the study. Two sources of data are analysed in this study: (a) secondary data from ACRA, EDB & DOS; and (b) primary data obtained from a survey of high-tech firms conducted by NEC using an online platform.

Macroeconomic Trends & International Benchmarking

1. Dynamism of High-Tech Sectors in Singapore

High-tech sectors contribute significantly to the Singapore economy, accounting for 13% of the employed labour force and generating 29.5% of total Value Added (VA). Productivity in high-tech sectors is more than double that achieved in non-HT sectors.

The high-tech services sector is the fastest growing segment of the economy, outperforming manufacturing and non-HT services sectors in firms, jobs and VA created. Firms in high-tech services also achieved higher profit margins and increasing return on assets (ROA). Comparably, the high-tech manufacturing has in the last five years registered declining number of firms and employment created, and lags behind non-HT manufacturing in sales and VA growth. Profitability in high-tech manufacturing is also declining with ROA values on a downward trend.

A summary measure of business dynamism is the *business churn rate*, calculated as the sum of firm formation and firm cessation rates. The high-tech services sector has consistently

registered the highest business churn rates since 2005. On the other hand, high-tech manufacturing has recorded the lowest business churn rate in the economy in recent years.

Overall, just over half the firms formed in Singapore five years ago (52.7%) are still alive at the end of 2015. High-tech firms have higher survival rates than non-HT firms, especially in the manufacturing industry. The “half-life” (ie time taken for the cohort of new firms formed in a reference year to be reduced to half its original number) for high-tech manufacturing is 6.5 years, while the half-life for non-HT manufacturing is 5.5 years. The margin between high tech and non-HT is much smaller in the services industry. The half-life for both high tech services and non-HT services is around 5.2 years. However, the gap widens after the seventh year and by the tenth year, the survival rate for high-tech services is almost three percentage points higher.

Taken together, the analysis concludes that the high-tech services sector is the most dynamic sector in Singapore. It is the fastest expanding sector and has the highest rates of firm formation, cessation and business churn. These findings point to a dynamic environment with healthy rates of business renewal and where young firms have a role in driving growth.

The high-tech manufacturing sector is conversely the least dynamic sector. In aggregate, firms in high-tech manufacturing grow at a slower rate than their counterparts in non-HT manufacturing. The rate business churn is also low. This suggests a business environment where growth is driven by dominant incumbents and the role of new or young firms is marginal.

2. International Benchmarking of Firm Dynamism

Compared against a basket of ten selected advanced economies, Singapore has among the highest rates of firm formation (ranked 2nd), cessation (ranked 3rd) and business churn (ranked 1st). The United Kingdom, USA and Denmark are the most similar to Singapore in exhibiting above-average rates for all three measures.

Survival trends of Singapore firms differ somewhat from UK and USA firms. Firms in USA are characterized by relatively low short-term survival before moderating in the medium term. In the UK, initial high survival in the first two years is followed by high attrition in the next three years. Singapore firms exhibit a more gradual survival pattern and have the highest five-year survival rate at 53% (compared to 49% in the USA and 42% in the UK).

Singapore’s firm dynamism profile is one of high churn and high survival rates. These characteristics are shared by the UK and Netherlands. This high churn-high survival profile may be interpreted as representing entrepreneurial hubs with infrastructure to facilitate firm entry and support young firms. Contrast this with the high-churn, low-survival profile of the USA and Denmark, which represent locations for high-risk entrepreneurial activities with the potential to be disruptive.

3. Startup Growth Trend

The Singapore Department of Statistics identified 48,071 startups operating in Singapore as at the end of 2015, using SPRING Singapore's definition of a startup as an enterprise with at least 50% individual ownership of shares, formed no more than five years ago and employing at least one salaried employee. Of these, 5,111 are high-tech startups (HTSUs).

The number of startups in Singapore has doubled between 2004 and 2015. However, this expansion is not evenly distributed. The number of startups in high-tech manufacturing has in fact been steadily declining since 2007. The high-tech services sector on the other hand has experienced significant expansion, especially in the period 2012 to 2015.

With the rising number of startups, employment created by startups has also increased over the years. The contribution of startups to total national employment rose from 7.1% in 2004 to 9.4% in 2015. There are considerable differences in startup employment growth rates between the different sectors. The high-tech manufacturing sector has experienced declining startup employment since the late 2000s. The star performer is the high-tech services sector, which has achieved the highest growth in the economy from 2007 onwards. In line with these trends, the composition of employment in HTSUs has altered substantially between 2004 and 2015. Previous concentration of jobs in the Machinery & Equipment manufacturing sub-sector has shifted towards Computer Programming and Engineering & Technical services.

Survey of High-Tech Start-ups in Singapore 2016

1. Profile of Start-ups

In total, 530 valid responses were obtained through the online survey. Survey respondents comprised 419 start-ups in the services sector (79.1% of sample) and 111 start-ups in the manufacturing sector (20.9% of sample).

Start-ups tend to be small in terms of employment and sales. Average employment of start-up is 11.6 while 56.1% had sales less than \$500 thousand in the most recent fiscal year. Approximately three-quarters of the sample are 5 years or younger and these young startups account for 56.3% of the total employment created by start-ups in the sample.

Employment distribution across the start-ups is found to be highly skewed – just 12.5% of start-ups are responsible for as much as 54% of total employment generated by the start-ups in the sample.

The findings demonstrate **positive association between employment and sales size** – as sales revenue increases, the number of employees in startups increases (Pearson coefficient = 0.4, significant at 1% level). Similar positive, but slightly weaker, correlation is found between employment and annual sales growth (Pearson coefficient = 0.22, significant at 1% level).

In terms of support and funding, 64.2% of start-ups had participated in at least one government support scheme. Among them, schemes offered by SPRING are the most prevalent especially among the young start-ups, with 26% having participated in start-up

related schemes such as ACE Start-up scheme and SPRING SEEDs, compared to 20.2% of the mature start-ups. Participation in university incubation schemes among the young start-ups (15.9%) is also considerably higher compared to mature startups (6.1%). A comparison of the different university incubation programs offered revealed that programs offered by the National University of Singapore attracted the most participation from the start-ups surveyed.

Self-funding remains the top source of funding for start-ups. While mature start-ups have a higher propensity to rely on more traditional sources of financing such as loans and debt funding (24%), young start-ups had a greater tendency to rely on public sector grants instead. 18.8% of young start-ups had received grants from the public sector compared to 10.5% of mature start-ups. This highlights the importance of government assistance in bridging gaps in early-stage entrepreneurial financing.

Funding from venture capitalists (VC), business angels (BA), and corporate investors are more common among the young start-ups as well. Slightly more than a third (36.8%) of young start-ups have received such funding compared to 28.5% of mature start-ups. More importantly, ***propensity of startups to be funded by VC, BA or corporate investors is higher among those that have participated in government support schemes, have participated in university incubation programs, own IP assets, are more innovative and are founded by serial entrepreneurs.***

Key founders who are serial entrepreneurs raise higher amounts of external equity funding. 35.6% of startups founded by serial entrepreneur have received \$500 thousand or more in external funding. In contrast, only 22.1% of start-ups founded by first-time entrepreneurs have received the equivalent amount. The difference is a reflection of the value imputed to the knowledge, networks and resources accumulated by experienced entrepreneurs.

2. Growth, Markets & Internationalization

Almost one-quarter (24%) of start-ups surveyed have not recorded any revenue, while 29% are revenue-positive but cashflow-negative. 23% have achieved positive cashflow and the remaining 24% are in the self-sustaining growth stage i.e. cashflow generated by the firm is sufficient to sustain their future growth.

Sales growth per annum of all start-ups over the last 3 years averaged at around 44.9%. As many as 1 in 4 young start-ups has achieved more than 100% annual sales growth over the last 3 years while only 1 in 10 mature start-ups are able to maintain more than 100% sales growth.

Further exploratory analysis was carried out to identify possible factors that may influence the growth performance of start-ups. ***Innovation and ecosystem support in the form of university incubation programs are found to positively correlate with sales growth.*** Start-ups that spend more on R&D, introduced new products/services or possess more patents, trademarks or copyrights have a higher propensity to attain higher sales growth. Technology readiness at founding is also a possible influencing factor - average sales growth is higher

among start-ups that spend 3 to 5 years in product/ service development and have at least an alpha prototype of their main product upon founding. For young start-ups especially, founder-related attributes such as age and country of birth are also found to correlate with sales growth.

Growth strategies of start-ups are found to evolve and change substantially after the initial stages of their existence. Internal organic growth and strong emphasis on product or service development were cited as the main growth strategies of mature start-ups in the past 5 years. In the next 5 years, these start-ups expect to shift their focus towards a more outward-oriented growth strategy with most looking into expanding their businesses overseas to increase revenue and to work with firms in overseas markets.

Hiring human resources is the most critical issue for tech startups in Singapore. 77% of startups cited HR-sourcing difficulties among the top 5 challenges they currently face as they attempt to grow. 14% of start-ups stated recruiting and retaining key personnel as their top concern while 19% specified hiring employees in general as their number one concern.

Almost half (45%) of startups operate in growth markets while a quarter are in emergent markets. **Startups that operate in emergent and growth markets enjoy significantly higher average sales growth** compared to startups that operate in mature markets. Young startups in the emergent and growth markets reported average sales growth of 63.8% compared to the much lower 29.1% reported by young start-ups in mature markets. However, higher sales growth does not mean that those in emergent and growth markets would take a shorter time to generate positive cashflow. Among those that took less than 3 months to achieve positive cashflow, a healthy percentage (43.1%) operate in mature markets.

Over 50% of start-ups have moved towards internationalization by establishing overseas operations. 72.2% of start-ups derive revenues from abroad, with overseas sales accounting for 26.5% of total sales on average. Southeast Asia (33.8%), China (12.6%) and India (11.3%) are the top 3 preferred countries to establish overseas operations. Among the young start-ups, East Asia is increasingly popular, with 10.3% of young start-ups having established their operations there.

3. Technology & Innovation

Findings demonstrate a general preference towards combining both in-house and external sources of technology, particularly open-sourced technologies, in the firm's main product/service (55%). Technologies acquired from outside the firm are typically licensed-in rather than purchased or jointly-developed, and companies are the main go-to external source for start-ups. Almost a third of start-ups chose to rely on in-house developed technology only.

Young start-ups are found to be more innovative than mature startups, with higher proportion that focus on introducing products or services completely new to the world (46.1% vs. 35.4% of mature start-ups). **Start-ups that develop their core technology in-house and have high R&D spending intensity have a higher propensity to be innovative.** Innovative

start-ups attain significantly higher sales growth (average 70.4% per annum) than less innovative firms (average 41%).

In terms of innovation cooperation, 71.3% have engaged in some form of innovation cooperation with external partners, most commonly with customers/clients. The lack of manpower/talent is once again highlighted as a key obstacle to not only growth but also innovation cooperation. Uncertainty over return on investments in collaboration together with problems of aligning objectives with partners are ranked second and third as obstacles to innovation collaborations.

4. Founders of High-Tech Start-Ups

The majority of startups are founded by a team, while 29.8% are established by individual founders. The key founder of a high-tech firm has this typical profile: Male (90.3%), aged 39 years and younger (55.5%), born in Singapore (55.7%), with university education (51.1% with a STEM Bachelor's degree, 20.8% with Bachelor degree in other disciplines), trained in a technical discipline (74.2%) and a first-time entrepreneur (58.1%). The overwhelming majority of founders possess some working experience prior to starting-up (93.2%), typically in leadership roles at SMEs or large MNCs/large local firms.

5. Job Creators and Fast-growing Start-ups

More in-depth analysis was carried out on two topics of interest: (i) job-creation and (ii) growth of start-ups. Distinctions were made between two groups of startups in job creation; 'job-creators' - top 25% of start-ups which create the most number of jobs per year and 'non-creators' - start-ups which create 0 jobs or had negative job growth. Similar distinction were made in the study of sales growth; 'fast-growing' start-ups with 3-year annual sales growth belonging to the top 25% of the sample and 'slow-growing' referring to the bottom 25%. Similarities between start-ups classified as 'job-creators' and 'fast-growing' are found.

Both job-creators and fast-growing startups are more deeply engaged in the startup ecosystem. They are found to have higher propensities to participate in government support schemes, university incubation programs and have received at least one form of funding from VC, BA or corporate investors. 62.4% of job-creators reported that they have received funding from at least one VC, BA or corporate investor. This is more than three times the number of non-creators (17.7%). For fast-growing start-ups, 45.7% of mature start-ups and 55.8% of young start-ups have received funding from similar sources. The figure for slow growth are significantly lower at 18.9% for mature and 33.3% for young.

Job-creators and fast-growing start-ups are more innovative. 56.9% of job-creators have introduced product or services that are completely new to the world compared to 35.2% of non-creators while more than twice the number of fast-growth have done so compared to the slow-growth sample.

Top concerns shared by the job-creators and fast-growing start-ups centred on employment challenges. In contrast, non-creators and slow-growing start-ups tend to focus

on challenges associated with internal growth, with obtaining financing for working capital ranked as the top growth challenge for non-creators and young slow-growing start-ups.

Tracer Study: Growth & survival dynamics of start-ups started in 2005-2009

296 start-ups that were founded in 2005-09 were surveyed back in 2010. Out of these 296 companies, 84% have survived, 2% have been acquired while another 14% are no longer in operations as of March 2016.

62 firms that participated in the 2010 study responded to the tracer survey. Approximately 80% are from the services sector and 62.9% of tracer firms are aged between 5 to 9 years old at present.

1. Growth & Internationalization of Tracer firms

Total employment of tracer firms has grown over the years. Firms tend to start small with an **average of 2 employees when founded and have steadily grown from that starting point to 8.6 employees in 2010 to 16.8 in 2016**. Approximately half of the tracer firms currently employ more than 10 employees, up from a mere 24.6% in 2010.

In terms of sales and growth stage, a higher proportion of tracer firms has progressed to a more advanced financial stage by 2016. 70.9% are currently cashflow positive or in the self-sustaining growth stage, increased from 62.9% in 2010. A comparison between the target sales growth set by tracer firms in 2010 and their actual sales growth reported in 2016 show that approximately **20% of the firms have exceeded their target sales growth by more than double**. Another 21% achieved their indicated targets while 38.7% failed to meet their growth targets set in 2010.

Slight changes in growth challenges faced by the 62 tracer firms are observed since 2010. While high investment costs to expand business took the top spot in 2010, **dependence on major customers is now ranked as the top concern in 2016**. On the other hand, employment-related concerns such as recruiting and retaining key personnel (rank 2nd in both 2010 and 2016) continue to dominate as one of the key challenges faced by tracer firms.

An increasing number of tracer firms have made the move towards internationalization. 54.8% of tracer firms reported that they have established operations overseas, up from 34% in 2010. More than 90% of tracer firms currently derive sales from overseas customers, compared to 75% in 2010.

2. Ecosystem support and Innovation

Participation in government support schemes among the tracer firms has more than tripled from 2010 (19.3%) to 2016 (69.4%). Compared to 2010 where only 16 firms had external

funding, all 62 firms have received some form of external funding by 2016. Among the 62 tracer firms, 12.9% have received VC funding by 2016, up from 6.8% in 2010.

A significant shift in the development of core technology is observed. Largely reliant on in-house development in 2010, 71.7% of tracer firms now rely on a combination of in-house developed and external sources of technology for their main product. Emphasis on innovation has increased over the years as well through increased participation in innovation collaboration with external partners (67.7% in 2016, up from 34.6% in 2010) and the introduction of products that are new to the firm (72.6% in 2016, up from 62.7% in 2010).

Change in Dynamics of Young Startups: 2010 vs. 2016

Young start-ups surveyed back in 2010 (n=304) were compared against young start-ups in 2016 (n=416) to explore possible differences in key attributes and growth dynamics. ***Disparities are found in three areas: (i) support and funding, (ii) innovation, and (iii) technology and key founders' characteristics.***

Participation in government support schemes has increased significantly among young start-ups from 23.5% in 2010 to 63.7% in 2016. Young start-ups in 2016 also have a higher propensity to receive funding from VCs compared to their counterparts in 2010.

Greater emphasis on innovation and technology among young start-ups in 2016 are noted. Higher IP ownership (49.5% vs 19.6% in 2010), higher propensity to introduce new products (74.4% vs. 61.5% in 2010) and more frequent engagement in innovation collaborations are observed of young start-ups in 2016. In fact, the proportion of young start-ups that have engaged in innovation co-operation has doubled from 31.4% in 2010 to 70.9% in 2016.

Concerning founder characteristics, findings show an increased share of young start-ups founded by females in 2016. 10.6% of young start-ups are founded by a female in 2016 compared to 5.9% in 2010. Founders are increasingly younger and trained in technical disciplines. 61.9% are aged 39 years and younger (53.6% in 2010) while 3 in 4 key founder have at least 1 STEM qualification (41.2% in 2010). Serial entrepreneurs are less common in 2016 (43.5% in 2016 vs. 53.4% in 2010) and key founders are more likely to have some form of work experience (91.3% in 2016 vs. 84.9% in 2010) typically oriented towards business functions prior to starting.

Conclusions

Singapore has high levels of firm dynamism when compared to other advanced economies

- Among a basket of advanced economies, Singapore ranks among the highest on a number of firm dynamism indicators: firm formation (2nd), cessation (3rd), business churn (1st) and short-term survival (5th). Singapore's firm dynamism profile is one of high churn

and high survival rates, suggestive of an entrepreneurial hub with infrastructure to facilitate firm entry and support development of young firms.

High-tech services is the most dynamic sector in Singapore

- Firms in high-tech services operate in an environment with healthy rates of business renewal and in which young firms have a role in driving growth. Conversely, the high-tech manufacturing sector is the least dynamic, with comparably low growth which is likely driven by dominant incumbents with marginal contribution by new or young firms.
- Startup activity is most dynamic in the high-tech services sector, where there has been rapid expansion in the number of startups and startup jobs. Growth is fastest in the Computer Programming & Consultancy sub-sector. On the other hand, startups in high-tech manufacturing have been declining in numbers as well as jobs created.

Growth performance of startups is skewed and associated with multiple factors

- Growth performance of startups is unevenly distributed. A small number of startups account for a disproportionately large share of startup jobs. Only one-fifth of young startups are self-sustaining while 60% are not yet cashflow-positive.
- Factors that correlate with growth performance:
 - o Innovation: R&D spending intensity, introduction of new products/services, ownership of IP assets
 - o Ecosystem support: University incubation, funding from VC, funding from BA
 - o Technology readiness: time spent on product/service development before founding, have alpha prototype upon founding
 - o Strategy: Internationalization, focus on emergent and growth markets

Startups are increasingly engaged with the startup ecosystem

- The rate of participation in government support schemes is high (69%) and has increased since 2010 (19%).
- Government grants are important for bridging gaps in early-stage financing.
- Funding from VCs, BAs and corporate investors has grown in importance since 2010. Startups are more likely to secure such funding if they own IP assets, are innovative, are founded by serial entrepreneurs, have received government assistance and have participated in university incubation programs.

Singapore startups have high levels of innovation activity and technological capability

- A significant proportion of Singapore startups are highly innovative, having introduced a product or service that is completely new to the world (46% of young startups, 35% of mature startups).
- Innovation level of startups has improved since 2010 – more firms currently own IP, introduce new products/services and engage in innovation collaboration projects.

- The majority of startups have the capacity to develop their core technology in-house, although the preferred technology sourcing strategy is to combine in-house development with open and external-sourcing.
- Startups have higher propensity to be innovative if they (1) develop their technology in-house, and (2) have high R&D spending intensity.

Growth strategies of startups are focused on internationalization, while challenges faced are HR-related

- Growth strategies change substantially as startups mature. In initial stages, startups prioritise internal organic growth and developing product/service. As they survive and grow, startups shift their strategic focus towards overseas expansion and international linkages.
- Hiring human resources is ubiquitously cited as the most critical challenge facing Singapore tech startups.
- Market strategies are outward-looking. Three-quarters of startups operate in emergent and growth markets. Over 50% have established overseas operations and 72% derive revenues from overseas customers.

Founder characteristics are slowly changing to be more diverse

- The typical founder of a tech startup in Singapore is male, tertiary-educated and trained in a technical discipline.
- There is some diversity in terms of age (44% aged 40 and above), nationality (44% foreign-born) and experience with entrepreneurship (42% serial entrepreneurs).
- Compared to 2010, there is an increased share of females, younger entrepreneurs and those trained in technical discipline.

Experience of tracer firms affirms the importance of innovation, internationalization and ecosystem engagement for firms to survive and grow

- Firms in the tracer study sample have grown in terms of: (1) number of employees; (2) more firms progressing to self-sustaining or cashflow positive stage.
- The majority of tracer firms achieved or exceeded the sales growth targets set in 2010.
- Tracer firms have evolved in the following ways:
 - Greater internationalization – overseas customers and overseas operations
 - Higher participation in government support schemes
 - Higher propensity to be externally funded
 - External technology sourcing
 - Increased participation in innovation collaboration
 - More innovative – introducing products new to the firm