Capacities extractivism: the case of the Argentine software and computer services sector

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Abstract

The Argentine software and computer services sector (SSI) has been active for two decades, driven by public policies and international outsourcing. However, growth in the sector has currently stagnated. This stalling is the result of the extractivism of capacities that operate in three ways: price-salaries, training and financial. The first explanation is the growing competition for costs resulting in contractions of wages and benefits. The second is capacity building that is geared to the requirements of international demand in standardized skills. The third is the financial valuation of the undertakings. This article builds a set of statistical information that enables this phenomenon for the Argentine case to be described and documented.

Keywords: software and computer services (SSI); extractivism; export of services; economic development.

1. INTRODUCTION

Over the past two decades, the Argentine software and computer services sector (SSI) has become established as a global provider within a group of emerging economies. These sectors are all placed in the least complex links of the SSI global production chain, regardless of the differences between them (Chaminade and Vang, 2008; Parthasarathy, 2013). This placement is due to the new context of an international division of labor, within sectors that are traditionally considered knowledge-intensive, allowing peripheral countries to participate as service providers whilst being a long way from having the ability to accrue technological revenue.

Argentina's success as an exporter stems from developing a sectoral strategy, the design of which came from conversations between the private and public sectors and academia (Barletta *et al*., 2017). Some of the actions developed around this strategy included a sectoral promotion scheme (software and knowledge economy laws), strengthening the sectoral institutional framework and increasing education in the field. The sector responded positively to these incentives, with strong growth in employment, turnover, and exports. [1]

Nonetheless, this success in exports needs to be reassessed in the light of how the sector took part, and the opportunities afforded for up-grading (Moncaut *et al.,* 2013). In a country with recurring balance of payments crises (Abeles *et al*., 2013), the industry's success tends to be attributed to its trade balance. However, this article argues that a strategy based almost exclusively on generating foreign exchange can create limitations for long term sectoral development. This is particularly true when growth is based on engaging in segments of the SSI production chain that are intensive in standardized or widely acquired knowledge, at an international level. The increasing competition to reduce costs internationally can erode profits, which disincentivizes replicating the skills acquired.

A great part of the literature that analyses this sector focuses on explaining its growth and dynamism (Barletta *et al.,* 2013; López and Ramos, 2018). This article proposes an analysis of the limitations of this growth, which is characterized by "extractivism of capacities". Engaging at an international level in low-value segments makes it difficult to replicate growth, and gears capacity-building to fit global chain requirements.

But what are the depletion indicators in the current sector's development model, and what factors explain them? The hypothesis of this study is that the development model's limits are endogenous and inherent to taking part at an international level. The SSI export model leads to the sector's production capacities being used (including companies, workers, and education systems), eroding instead of stimulating their growth. Growth erosion occurs despite these production capacities being key in achieving the Argentine sector's current levels of development. We recognize that companies in this industry operate in a heterogeneous manner and that there are cases that differ from this model; however we believe this to represent the general trend.

The concept of extractivism has been applied in informational contexts (Rikap, 2021) and to the SSI value chain (Artopoulos, 2020). We aim to contribute to existing literature by examining three ways in which extractivism impacts on the Argentine SSI structure. The "price-salary method" manifests as a downward trend in labor productivity and in remunerations for work and capital. The "financial method" operates by foreign interests acquiring the most successful new businesses. The "skills method" can be seen in the stagnation and weakening of education and research in computer sciences.

Following the introduction, the article is organized in the following manner. The second section focuses on the concept of capacity extractivism, and the three ways to achieve it. The third section describes the methodology and indicators that allow each of the ways to be understood. The fourth section presents an analysis of the empirical information collected for the proposed indicators. The last section presents the main conclusions reached.

2. THE CONCEPTUAL FRAMEWORK

This section contains a description of the development model of the Argentine SSI, as seen through two lenses, an exploitation model that is replicable, and a non-replicable exploitation (or extractive) model. This is based on the effects of using capacities developed within the country in which the sector's activity takes place. According to Moncaut (2019), a development model is considered replicable when the sector's capacities used, in this case the work force and the organizational and technological capacities accumulated by businesses, are reproduced, and create growth within the sector. The non-replicative or extractive model is one in which the sector's capabilities are used in such a way that they are depleted, or geared to create lower value capabilities, instead of being maintained or increased.

Capacity Extractivism in SSI

The concept of extractivism tends to be used to refer to economic activities linked to the extraction of natural resources. Specifically, the term refers to an overexploitation of such resources, destroying biodiversity and negatively impacting on the territory (Svampa, 2013). In this article, the use is broadened to describe the way skills are utilized in the production of SSI, redirecting them to short-term private interests that are not aligned with long-term development objectives of the country in which they are developed.

The regressive reconfiguration of skills can seem counterintuitive, to the extent that their implementation should lead to learning due to experience and interactions (Lundvall, 2009). Nonetheless, in this article we discuss how the stakeholders who have and produce the skills (workforce, businesses, and scientific-technological-education systems) are assigned specific activities with a type of financial compensation that makes it difficult to replicate their initial skillset. The general hypothesis of work is that the assignment of tasks, implicit in the export model of computer work hours, implements skills that are lower in value than skills initially acquired. These are highly circulated skills that require less training time, and have standardized work processes, with limited control or knowledge of the complete production process and with few opportunities for a knowledge exchange between provider-user (Moncault *et al.*, 2017). These characteristics make the Argentine SSI sector vulnerable, as it has tended to specialize in a model that is continually more competitive at a global level, in addition to the fact that technological developments in SSI advance at an exponential level.

There are some differences with the extraction of natural resources. First, these tend to be coordinated by one or a few multinational companies that operate within a country to exploit resources under an export-enclave model (Svampa, 2013). When looking at SSI one can initially see that it is made up of a dense network of organizations, institutions, national and international regulations. The role of the foreign companies involved can be identified as the stakeholders coordinating the activity: they define the product's characteristics, demand that technical specifications and best practices be followed and control access to the final market and intellectual property. It is also clear to see that there are a lot of foreign companies capable of fulfilling this role and that they compete with one another. Second, within the SSI sector, the production chain is commanded from abroad, with no need for global companies to set up in the country within which they are exploiting the resources or capacities. Finally, the actions of domestic capital companies are guided by incentives given by the international division of labor, as well as the local legal framework, in the case of Argentina, the Software Law (Moncault *et al.*, 2021).

The three extractivism methods

As mentioned in the introduction, three methods of capacity extractivism in the Argentine SSI sector have been identified: the price-salary method, the financial method, and the skills method.

In principle, the price-salary method works through market signals. When market signals determine a price (the most competitive being chosen) for skills and computer knowledge, a framework is established, and workers and entrepreneurs decide which activities to specialize and work in. Skills with a market pay rate below the amount needed to replicate them (whether it is because the costs of replicating them are higher or because the incentives to produce them are lower than for other skill sets), will stop growing. The price-salary method of extractivism works when the resources obtained in exchange for services, or hours worked in the SSI sector, are not high enough to incentivize increasing or maintaining the skills of companies and workers at the level they were, prior to being hired. The hypothesis obtained from this method is that due to an international presence in low-value segments, sectoral salaries and benefits reduce with time, making it hard to recreate these skills.

The financial method operates by halting the growth of skills within the national business network due to the owners' strategy to achieve financial appreciation. Successful entrepreneurs need complementary assets and financing to scale and increase the value of their innovations. They also face risks that increase within the context of growing competition and the arrival of the price-salary method of extractivism mentioned previously. This leads to entrepreneurs adopting strategies that require turning to global risk capital, mergers, and takeovers. As long as innovative local business owners seek short-term increase in value of their companies with loss of control, the benefits of the innovation are difficult to reap by those within the area that gave rise to the innovation itself. Simultaneously, growth of skills stops at a local level. Thus, the financial method works by gearing the entrepreneurs' incentives towards a quick appreciation of their businesses' value, instead of creating technological solutions. In other areas (such as nanotechnology or biotechnology) this can happen with intellectual property. In the case of SSI, the main way of achieving this is to take control of the company. These incentives gear business owners' attention to a path of global growth, highlighting potential tensions with local development strategies. The hypothesis put forward for financial extractivism is that it creates a tendency of setting up SSI companies to sell them on the global stock market, a tendency on the increase. This can be seen in the decrease in time between the business being created and sold to a third party. A pattern of innovation that is severed from the local sector's trajectory and the potential interactions with other productive sectors is then created.

The skills method functions by reshaping skill sets in workers, businesses and even the scientific-technological system, be they formal/informal; academic/scientific/industrial. This occurs when education and research times stagnate or are reduced, or by specializing in certain activities leaving others underutilized, leading to a process of "unlearning by not doing" (Coles and Masters, 200; Hislop *et al.,* 2014; Moncaut, 2019). Even though the activities that become more important in sectoral specialization led by international demand give rise to learning processes, the tasks assigned proposed by the export model of hours of computer work use less complex skills, requiring less training.

The hypothesis is that with this type of extractivism, a process of reshaping education towards simpler computer science careers can be seen in time. Education is cut short for a premature entry into the labor market, consistent with the salaries that educational extractivism leads to.

3. METHODOLOGY

An overview of the price-salary method

Although the cost of replicating workers' or entrepreneurs' skills is difficult to estimate, we have chosen a price-salary method approach, based on an analysis of changes in the sector's main indicators, including turnover, export, jobs and payments. The data was obtained from the Permanent Observatory of the Software and Computer Services Industry (OPPSI) and the Employment and Business Dynamics Observatory (OEDE). The sector's labor productivity and net income of wages are per business (a proxy for business payments). It is not possible to determine whether these payments are sufficient to cover the costs of skills replication, but a trend of these contracting was found. This, combined with the hypothesis that capacity reproduction costs remain at a constant, gives indicators that the model is depleted. Using data from Stake Overflow,[2] the trend in salary gaps among workers in equivalent jobs in the United States, India and Argentina was calculated.

Rabosto and Zukerfeld (2019) also analyzed the salary dynamics and the conditions present for replicating the SSI in Argentina. This article also shows changes in net turnover of salaries per business, as an indicator of the difficulties of reproducing business skills. The use of the salary gap compared with other countries as an indicator of the difficulty of reproducing Argentine workers' skills was used by Cazón *et al.* (2017), Kozlowski (2016) and Graña *et al.* (2022), although none of these applied it specifically to SSI.

An overview of the financial method

We propose to study the speed with which Argentine SSI businesses are acquired. Using the Crunchbase[3] database, Argentine businesses and businesses created by Argentines living in other SSI countries were identified, whilst simultaneously analyzing the changes in the number of early-stage businesses being acquired (less than five years from being founded). This indicator provides an original proposal, based on precedents found in specialized literature, showing the difficulty in accumulating skills and knowledge at a territorial level due to the acquisition of businesses by foreign entities (Gonzalo *et al.*, 2013).

An overview of the skills method

When analyzing this method, workers' education in computer sciences was studied, both in terms of quantity and quality. The Secretariat of University Policies' (SUP) database was used to create lists of people enrolled and graduated from undergraduate and post graduate degrees, specializing in computer science. The changes in participation of newly enrolled students and those enrolled in short degrees (undergraduate) were analyzed against the total of students enrolled and graduating from computer science degrees respectively. These indicators have already been used by Rabosto and Zukerfield (2019) to show the difficulty of reproducing knowledge and skills in SSI.

Summary of Indicators

Table 1 is a synthesis of the indicators used to approach the different extractivism methods and the data sources used.

Table 1. A synthesis of indicators used for the extractivism methods

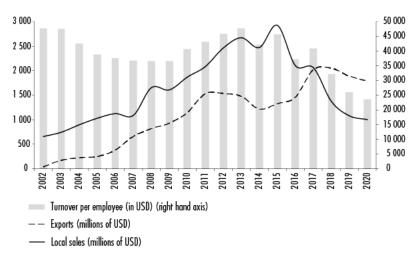| Extractivism method	Indicator	Data source
Price-salary method	Changes in income for businesses net of salaries (a proxy for gross operating surplus)	OPPSI and OEDE
	Changes in wages in dollars	OEDE
	Changes in the salary gap of computer workers in Argentina compared to India and the USA	Stock Overflow
Financial method	Changes in the number of companies acquired founded less than five years prior	Crunchbase
Skills method	Participation of enrolled students and graduates in undergraduate degrees compared to the total of computer courses	SPU

Source: created by authors.

In addition to the quantitative information, qualitative data was collected throughout, using exploratory interviews with key stakeholders. These were eight entrepreneurs from the sector, three directors of computer science research centers and teachers and three representatives from key sectoral institutions in Argentina (The Sadosky Foundation; The Chamber of Software and Information Services, CESSI; The Tandil Chamber of Computer Companies, CEPIT). Secondary information from news articles was also used. Qualitative information was used to contextualize and interpret tables and graphs.

4. EMPIRICAL RESULTS

Price-salary method

An initial observation of the changes of the Argentine SSI sector's principal indicators reveals a downward trend in productivity (measured as total turnover in dollars per employee) beginning in 2013 (see figure 1). This translates to a sustained increase in the number of workers who have consistently outperformed the growth of invoice volumes.

Figure. 1. Changes in productivity by employee, exports and sales made to the internal market by the Argentine SSI

- Turnover per employee (in USD) (right hand axis)
-- Exports (millions of USD)
— Local sales (millions of USD)

Source: created by the authors using data from, OPSSI and OEDE.

Measuring productivity is complicated. The estimate of turnover and aggregate value involves, not only the amounts traded (which is difficult to measure in services or the intangible goods sector) and the relative amounts (heterogenous products and services with different prices), but the amount of work that is known to be heterogenous because it involves different skills and work experience. Furthermore, the dollar productivity indicator is affected by exchange rates (used to express sales in dollars to the domestic market), which adds an additional layer of complexity to the analysis of changes in this indicator when looking at Argentina, as it suffers from severe currency volatility.

The following equation shows the calculation of productivity. Ql is the amount of SSI sold to the domestic market, Pl is the average price of domestic SSI (in Argentine pesos), E is the rate of exchange, Qx the amount of SSI exported, Px the average price of the exported SSI and finally, *Employee* is the number of workers employed in the sector.
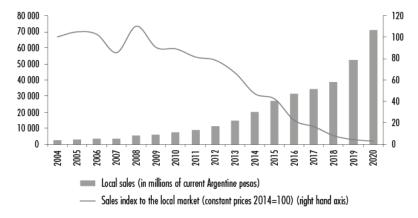
$$Productivity\ in\ US\ per\ employee = \frac{\frac{Ql.Pl}{E} + Qx.Px}{Employees} \qquad (1)$$

The above equation serves to analyze the changes in productivity based on changes in its various determinant factors and thus find the possible explanatory factors for the downward trend suffered.

i) A fall in total turnover explained by the decrease of sales to the internal market expressed in dollars. These went from $27 200 million Argentine pesos in 2015 (equivalent to $2900 million USD) to $70 900 million Argentine pesos in 2020 (equivalent to $1000 million USD). The abrupt contraction of this indicator began in 2016, partially in response to currency fluctuation (a more pronounced increase in the exchange rate than that of the prices of domestic sales).

Figure 2. Local sales at current prices and constants of the Argentine SSI sector

- Local sales (in millions of current Argentine pesos)
— Sales index to the local market (constant prices 2014=100) (right hand axis)

Source: created by the authors using data on local sales from OPSSI, the nominal exchange rate from the Central Bank of Argentina (BCRA), and the implicit price index from The National Institute for Statistics and Census of Argentina (INDEC).

However, local turnover valued in local currency and deflated by the Implicit Price Index (IPI) that corresponds to "Real estate, business and rental activities" (in which SSI activity is included) is used as a proxy for the amounts sold to the local market and also shows an uninterrupted downward

trend beginning in 2008 (see figure 2).[4]

We leave it to future researchers to analyze the factors that explain the sector's fall in sales to the internal market, something of great relevance within the context of a boom in policies geared to the development of 4.0 industry (highly intensive in computer solutions) and of a great deficit in terms of digitalizing Argentine industry and public services (Motta *et al*., 2019). Meanwhile, when looking at offers, there are incentives to allocate production factors to exportable services. Beyond the potential of international demand, or the difference in price that outsourcers abroad can pay, the Software Law and the Law for Thought Economy include the increase of exports in their requirements for access to fiscal benefits (Moncaut *et al.,* 2021).

ii) A drop in total turnover due to a decrease in exports. Sales abroad decreased since 2017 (see figure 1).

There are various explanatory factors worth considering. A decrease in turnover for exports could be caused by the exchange rate splitting. The increasing gap between the official rate of exchange and the parallel incentivizes exporters to under declare their sales abroad to be able to keep foreign currency, rather than exchanging it to Argentine pesos at the official rate. However, this theory does not apply to the end of 2015 and mid 2019, during which the exchange gap was almost zero due to the deregulation of the foreign exchange market. It could also be due to a fall in hiring from abroad, due to a lower demand for international software or competition from businesses in other countries. Finally, it could be explained by a fall in product prices, and mainly in services exported. This could be due to a change of direction in exports to activities that are lower in value (in more competitive links of the SSI production chain) or to a fall in dollar prices due to an increase in international competition in activities outsourced abroad. In this scenario the global offer of products and services that Argentine businesses specialize in increases at a greater rate than the demand for them.

The fall in exports due to a reduction in value of the services sold can lead to an erosion of the sector's capabilities. If the reason is due to realignment of exports towards lower value services, these are probably activities that offer fewer learning opportunities (they require standardized knowledge that is more widespread). If, however, the fall is due to the exacerbation of international competition, the fall in prices becomes unsustainable, or disincentivizes the replication of skills acquired for a different cost/ salary pairing. If it were any of these cases, we would be faced with a manifestation of the pricing path of an extractive development model of local capacities in SSI.

The changes in turnover net of salaries by company[5] gives some insight into this. Although the number of companies in the sector shows sustained growth, the net turnover of salaries shows a downward trend since 2013 (see figure 3).
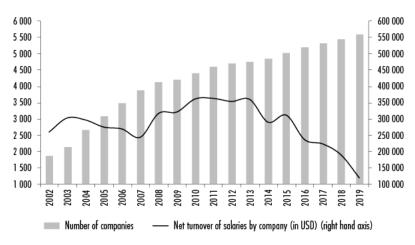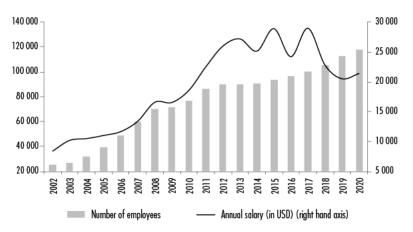
Figure 3. The evolution of net turnover of salaries by company in the Argentine SSI sector

Source: created by the authors using data from OPSSI and OEDE

This can mainly be explained by the fall in the sector's total turnover in dollars, as previously mentioned. In addition, it is due to an increase in the total payroll in dollars, which lowers the magnitude of the indicator numerator. This has been occurring since 2013. However, this is not due to an increase in salaries in dollars, but due to a sustained increase in the number of employees. In fact, the sector's employees' salaries in dollars have stagnated since 2015 and took a downward turn in 2017 (see figure 4).

Figure 4. Changes in the Argentine SSI sector's employment and salaries

Source: created by the authors using data from the OEDE.

The fall in salaries paid in dollars to workers hired by local companies creates an increase in the salary gap compared to salaries paid in the countries focused on. Table 2 shows the changes in the average salary in dollars paid to programmers in Argentina, India (the main global destination for computer service outsourcing) and the United States (the main source of the outsourcing). A growing increase in the pay gap with the USA can be seen, whilst the Argentine salary tends to become more and more similar to that paid in India.

Table 2. Changes in the average salary paid in dollars in the SSI sector

Country	2017	2018	2019	2020
Argentina	21 893	24 000	17 760	17 712
India	7 341	9 960	10 495	10 056
United States	93 000	100 000	108 000	112 000
Percentage gap with India %	-66	-59	-41	-43
Percentage gap with the US %	325	317	508	532

Source: created by authors using data from Stack Overflow.

On the one hand, the changes can be explained by a composite effect. It seems more jobs are being created in Argentina that require an increasingly similar educational background to those in India, rather than jobs in the USA (see table 3) and the salaries therefore tend to converge with India's.

Table 3. Percentage participation of IT workers by level of education (2020)

Country	Incomplete high school and university	Undergraduate degree completed	Postgraduate	Total
Argentina	54	37	9	100
Brazil	27	60	13	100
India	4	71	24	100
United States	15	63	22	100

Source: created by authors using data from Stack Overflow.

On the other hand, it can be explained by a real decrease in salaries in Argentina, in comparison to the US for the same jobs.[6] Workers in the industry feel incentivized to try to be hired as freelancers, directly by the foreign companies (Moncaut, 2019). In an interview by Vaveluk (2021), the Secretary General of the Computer Industry's Trade Union said the following in reference to this:

> Those same workers who reach the top in local companies, they try to hire them from abroad. This isn't regulated and the worker is making between 3 and 8 thousand dollars, depending on who hires them abroad, and the companies here are paying 150 thousand pesos [1 580 dollars](…) It's estimated that of the total of IT workers in the country, 50% are making between 77 thousand and 151 thousand pesos [between 810 and 1590 dollars], 25% make more than 151 thousand and the remaining 25% make between 30 and 40 thousand pesos [between 315 and 420 dollars].[7]

The direct hiring of Argentine computer and IT workers by foreign companies is boosted by the growth of new technologies that facilitate the organization of workers spread across the globe. On the one hand crowdworking platforms such as Amazon Mechanical Turk or Microtask.com, make it easier to coordinate a great number of simple tasks distributed to workers in different countries, which leads to contradictory effects on workers well-being (Graham *et al.,* 2017).[8] On the other hand, the financial innovations made in payment methods facilitates global transactions.

Thus, the business model of local companies based on managing workers to offer services in time and scale to satisfy the demand of global SSI outsourcing is under threat. Companies abroad find positives in not using local companies, as they can pay less for the hours worked when they are a direct hire. Meanwhile, local workers can obtain higher salaries than those paid at a local level by offering their services to foreign companies. Both factors limit the growth and make use of SSI skills at a local level, even when workers remain in country.

The financial method

By interviewing key players (entrepreneurs in the sector, researchers, people involved in government) it emerged that the tendency to start companies with aim of selling them has increased in past years. The pandemic generated new waves of company acquisitions (by foreign and national companies) provoking an increase in economic concentration and of the presence of foreign capital in the sector. This is comparable with the growth and development of financing innovation activities through risk capital, accelerators, and investment funds. Although this tendency is particularly noticeable in high income countries, it is starting in countries of the region (Kantis *et al.,*2019). At the same time, there is a globalization of the "entrepreneurial ecosystem", allowing startups from peripheral countries to project globally, both in terms of the market for their products and services, as well as in access to financing. The phenomenon of global projection with technology businesses, and especially those in SSI due to the immaterial quality of their products and services, as well as the resources and assets needed to build their skills, which also favors strategies geared towards the financial appreciation of new businesses.

The key players view this dynamic optimistically, in spite of it being characterized here as the financial method for skills extractivism. For example, they argue that entrepreneurs increasingly start companies with the sole objective of selling them "it's good for the seller because they set up to sell (…) The companies' product is stock options, not what the company does".[9] And they say that there is a positive in selling as it allows the entrepreneur to avoid the severe difficulties of developing a business at a local level. [The entrepreneur] does not have a capitals market to allow growth here; they create it, to sell it, because at some level there is no opportunity for autonomous growth. They know that they are not going to be able to have a business that generates the value required in relation to the effort they put in, in the local market. ".[9]

Simultaneously, they see the advantage the buyer has; it allows them to expand their business model and their technological base without the risks inherent in the process of innovating. "All the entrepreneurial risk is taken on by small entrepreneurs and that is very profitable." [9], [10]
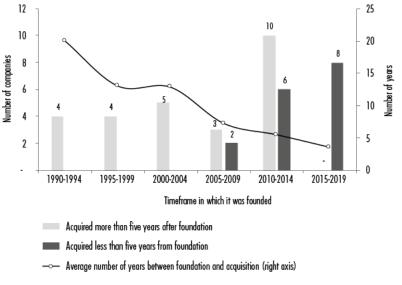
The tendency to turn to these external sources of financing, up to the point of losing control of the company, when faced with the risks and difficulty of scale, as well as growth at a local level, creates a double-edged sword within a national sectoral development strategy. In the first place, the valuation of a business undertaking will be higher through production than its sale. The lack of complementary assets justifies the sale from an individual perspective but does not guarantee the system being replicated. The companies acquired by other companies or those with foreign investors have developed products, attractive business models and or a client portfolio with access to strategic markets for business development. Moreover, despite it being maintained that the individual profit obtained in a merger or acquisition is reinvested into a new venture in the country, the goal of this new entrepreneurial venture will be its appraisal on the capital markets, reproducing a financial ideology rather than a productive one.

There is evidence of entrepreneurs who have sold their businesses and turned to financing as angel investors or risk capital investors (for example, Core Security Technologies whose founder started Aconcagua Ventures and then Satellogic). This feeds back into the growth dynamics of the financial markets for tech companies. Once the cycle of the financial method is set up, the profile of companies created, their business models and the technology used, come closer to a global technological trajectory than potential domestic trajectories.

The database for technological businesses, Crunchbase, was used to complement the information provided by interviews to key participants. 913 businesses from the SSI sector were located in Argentina[11] or founded by Argentines with turnover or employment information. Of these, 792 companies were in Argentina, 52 in the United States and the rest in different locations with Brazil, Spain and the United Kingdom coming up most frequently. This database, which only has companies whose core business is SSI[12] has five unicorn companies: Ualá, Nuvemshop, Auth0, MURAL and Letgo, of which only one is established in Argentina.

A first look at this data shows that when looking at the most recent acquisitions of Argentine companies, there is an increasingly short period of time between their founding and being acquired by a third party. For example, the businesses that were acquired in the 1990s registered at least five years of activity prior to being bought. However, all the businesses of the sample acquired by the end of the 2010 decade, had existed for less than 5 years. Figure 5 shows a marked downward trend in the average time between the year of the Argentine SSI businesses being founded and their acquisition.

Figure 5. The change in the number of Argentine SSI businesses acquired according to the time elapsed since their founding

Source: authors' own using data from Crunchbase

This makes it possible to identify a financialized business model (partly induced by the downturn in turnover by employee analyzed in the previous section), which threatens the growth of operational and technological skills in Argentina.

The skills method

Data on the evolution of training in computer science shows a drop in the participation of newly enrolled students in engineering and degrees versus a panoply of situations that include anything from undergraduate degrees to short training courses that are not held at universities (see figure 6).
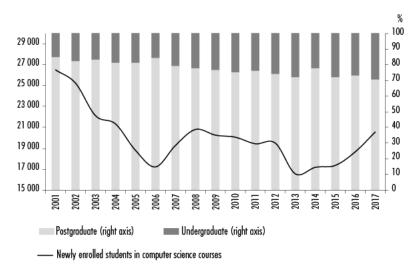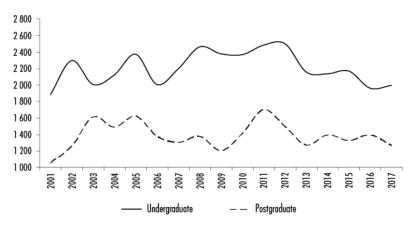
Figure 6. The change in the number of newly enrolled students in computer science postgraduate and undergraduate degrees in Argentina (by number of people and %)

Source: author's own using data from SPU.

The increase in demand for qualified workers in the job market in relation to skills developed education at university level has, on the one hand, given rise to a growing number of students abandoning their studies as they enter the labor market prematurely. On the other hand, it has caused tensions between academia and the private business sector, in so far as degree course curricula. Faced with this situation, universities have created undergraduate degree courses adapted to the timeframes and skills required by companies in the industry. These companies are in turn responding to the demand of the companies outsourcing these students from abroad. However, the rejigging of course work has not managed to stop the trend of students leaving their studies early, as can be seen by comparing the changes in newly enrolled students in undergraduate degrees (see figure 6) with those who have completed their undergraduate degrees (see figure 7). The flip side of the trend to leave education early, which shows a depreciation in the offerings of computer work, is the type of demand that the SSI companies fulfill in Argentina. As shown in Table 3, Argentina has the highest proportion of workers in computer sciences with the lowest educational level, among the countries compared.

Figure 7. Changes in the number of students completing undergraduate and postgraduate computer science degrees

Source: author's own using data from SPU.

The trend increases once students become researchers with a relatively low number of doctoral scholarships and enrollments in scientific research at the National Council of Scientific and Technical Researchers (CONICET), a council focusing on computer sciences and with curriculums and training courses concentrating on the procurement of IT tools. This can be seen in the qualitative evidence collected from key stakeholders in the academic sector (the ex-director of an important research institute in advanced computer science in Argentina, quoted below).

> "The institute currently has five doctoral students with scholarships, and about 20 researchers. The system is unsustainable. The first issue is that students aren't graduating, so undertaking a doctorate is not even in their plans, except for a minority of the minority who finish a degree or engineering degree. Only a few of those will accept to get paid what scholarships offer instead of an industry starting salary. This also has a clear impact in replicating teachers to train teachers. Taken to its limit, there won't be enough professors at university level in a couple of generations."

It is obvious that although this educational realignment is in response to international market needs, which can pay high salaries (in comparison to other manufacturing activities in Argentina), it is leading to dumbing-down rather than growth and increase in complexity. The simpler the tasks to be completed are, the more probable it is that the skills needed to achieve them will be widespread, creating a higher level of competition for each trained worker. This competition and the wide-spread availability of the knowledge required leads to a drop in pay. Similarly, this type of skills simplification could harm jobs with more complex requirements ((but with lower pay) within the local network.

Summary of results

The indicators analyzed allowed the specific hypotheses from the conceptual framework to be corroborated. First, when looking at the price-salary path, a real reduction in entrepreneurs' salaries was observed (measured using companies' turnover net of wages) and employees (measured using salaries in dollars and relative to employees' salaries holding equivalent jobs in the US), which assuming that replication costs are constant, can lead to a downturn in creating stakeholders with similar qualifications.

In second place, when looking at the financial path, there is an increasing predominance of Argentine businesses in the sector being acquired at an early stage. On the one hand, this reflects a decrease in the incentives for entrepreneurs to value skills productively (which relates to the price-salary path). On the other it shows the national dispersal of organizational skills, which are taken away with the companies acquired by international capital.

Finally, with regards to the educational path, there is a tendency to realign workers' skills to those that are less complex. This can be seen in the relative increase of students who are enrolled or have graduated from shorter computer science degrees and in the number of students dropping out of degree courses, which has not stopped with degree courses being shortened.

5. CONCLUSIONS

The data presented reveals a downward trend in productivity in the Argentine SSI sector, beginning in 2013. The information available supports the thesis that the very growth model in the sector brings about a realignment of skills and education in terms of SSI production, to activities that tend to decrease in value. This is a non-reproductive model of using skills, which is known as capacity extractivism.

The argument was made that skills extractivism in the SSI sector occurs in three different ways. First, the price-salary method influences the incentives to entrepreneurs and workers, swaying them respectively towards financial appreciation models and the direct sale of the work force to companies abroad. The simultaneous fall in local workers' salaries measured in dollars, and the turnover net of salaries per company, indicate that the current sectoral development model is specializing in activities that are decreasing in value and disincentivizing the acquisition of certain skills in the Argentine SSI sector.

Second, the financial method truncates the growth of skills in local businesses, as innovating entrepreneurs no longer seek to appreciate the value of their company through operational activity but seek their appreciation in capital markets. This trend involves effort in research and development, team-building, and organizational skills that are acquired at an early-stage by companies abroad.

In the third place, the educational method affects curricula for degrees in computer sciences, by simplifying them and realigning them to the needs of local businesses who are themselves led by their foreign clients' demand. The growing level of outsourcing activities internationally, of an increasingly low level, generates a growing demand for workers who have the skills needed for these tasks. Therefore, local businesses in the sector influence

training centers and universities to adapt their curricula and create specialized, shorter courses. Workers are then influenced by the market to opt for certifications instead of degrees or to leave their education early to join the job market.

In this context, the sector's development model, which is influenced by markets and supported by public policy, creates its own limits. The Argentine SSI sector has features of an export enclave, disassociated from national industry's needs. It has become condensed into a handful of internationalized companies that absorb human resources without a complete vocational education on a massive scale and compete successfully, due to the workers' skills and relatively low costs in various segments of low and medium complexity on the global market. This creates a loss of profits for companies and difficulties in reaping the benefits locally of national efforts in computer science education. It also leads to a disintegration of the State's technological skills, halting or creating difficulties in the development of large projects that could be a way to change this specialism's profile.

Public policy should promote strategies to value skills acquired at a local level. This could be achieved through a large company or government agency that leads the development of Information and Communication Technologies (TIC) and contributes to the cross-sector effect of SSI on productivity in the national industry's framework. The need for development of information and communication technologies abounds at a local level, but the lack of real demand impedes its development, despite the skills needed being present.

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[1] Several works have described this evolution Barletta *et al*., 2013 and 2017; López and Ramos, 2018; Moncaut *et al.,* 2013

[2] That surveys over 80 thousand workers globally

[3] Crunchbase.com is a database that compiles information on technology companies, mergers and acquisitions. The database holds information on more than 1.6 million companies and more than 120,000 mergers and acquisitions.

[4] The same exercise was performed using the Consumer Price Index (IPC) which covers the entire country and uses COICOP divisions (the Classification of Individual Consumption by Purpose) pertaining to services provided by the National Institute for Statistics and Census of Argentina (INDEC) and the trend is similar. This figure shows the IPI deflated data in order to have greater coverage.

[5] This indicator was estimated using the sector's total turnover in dollars (source OPSSI) minus the sector's total payroll (source OEDE). To estimate the payroll, the series of monthly salaries informed by the OEDE were calculated annually and converted to dollars at the BCRA exchange rate. Finally, the ratio between net turnover of salaries and the number of companies was calculated (OEDE)

[6] It is important to clarify that the tendency to decrease in dollar salaries can also be explained by the Argentine macroeconomic dynamic with a tendency to devalue the local currency. However, in the case of SSI this is highlighted by the size of the drop within the context of an internationalized sector in which global salaries tend to growth.

[7] The values in dollars were calculated using the average monthly exchange rate of the cited publication indicated by the BCRA.

[8] Graham *et al.* (2017) highlight that global employment platforms tend to have contradictory effects for digital workers in Southeast Asia and Sub-Saharan Africa. Some are benefited by access to better paid employment with better working conditions than that which is available in their own countries. However, an important tranche of workers is threatened by a decrease in negotiating power (as the possibility of unionizing lessens) and higher lack of formality in the working relationship.

[9] Literal quote from an interview of an Argentine SSI sector entrepreneur on the 12/02/21.

[10] This phenomenon is not exclusive to the SSI sector. The trend of creating tech startups to sell them is a wide-spread strategy in the sector (Pires-Alves *et al*., Gonzalo *et al.*, 2013).

[11] The information from this source represents 15% of the 5500 companies shown by public registers.

[12] This excluded the MercadoLibre database, as their principal category is e-commerce.