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ZAGACETA-GARCÍA (Juan Carlos), « Innovation dans les entreprises de services. L'analyse d'une classification sectorielle désagrégée dans le cas du Mexique », *European Review of Service Economics and Management*, n° 10, 2020 – 2, p. 49-71

DOI : [10.15122/isbn.978-2-406-11028-6.p.0049](https://doi.org/10.15122/isbn.978-2-406-11028-6.p.0049)

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RÉSUMÉ – Cet article est consacré à l'innovation dans les services au Mexique. Il s'appuie sur des données provenant d'enquêtes sur les entreprises de services réalisées dans le cadre des recensements économiques de 2004 et 2009. Ces enquêtes couvrent tous les types d'innovation, y compris les innovations en matière de produits et de services, de processus, d'organisation et de relations extérieures. L'analyse aborde également l'innovation au niveau des branches, allant ainsi au-delà des études conventionnelles qui se concentrent sur le niveau sectoriel. Nous comparons les résultats en utilisant les trajectoires technologiques de la taxonomie de Soete-Miozzo (1990). Les résultats de l'enquête indiquent que si tous les secteurs innover, les degrés d'innovation diffèrent en fonction des singularités intrinsèques du secteur considéré.

MOTS-CLÉS – innovation dans les services, changement technologique, pays en développement, Mexique, recensements

ZAGACETA-GARCÍA (Juan Carlos), « Service firm innovation. Disaggregated sectoral classification analysis for Mexico »

ABSTRACT – This article is devoted to innovation in services in Mexico. It is based on data from service firms surveys within the 2004 and 2009 economic censuses. These surveys cover all types of innovation, including product and service, processes, organisation, and external relationship innovations. The analysis also captures innovation at branch level, therefore going beyond conventional studies that focus on sector level. We compare results using technological trajectories from the Soete-Miozzo taxonomy (1990). Survey results indicate that though all sectors are innovating, degrees of innovation differ in line with the sector's intrinsic singularities.

KEYWORDS – service innovation, technological change, developing countries, Mexico, censuses

SERVICE FIRM INNOVATION

Disaggregated sectoral classification analysis for Mexico

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INTRODUCTION

All of the world's most advanced economies are dominated by the service sector. In many, it accounts for more than 70% of their GDP. The service sector is also important for developing and emergent countries (OECD, 2011); for example, it accounts for 52.2% of GDP in China, and 60.1% of GDP in Mexico (World Bank, 2018). Service growth is projected to continue in both groups of countries.

Innovation surveys show that firms invest in innovation in order to gain market share, reduce costs, and increase profits (OECD, 2000). The traditional way of grouping service firms is by industry or by sector (hospitality, banking, telecommunications, transportation, maintenance, etc.). This classification is standardised, to some extent, across countries, so there is data that can be compared across countries, sectors and firms. However, in most developing countries, there is neither any such consensus nor sufficient information available to measure service innovation and its effects.

This paper aims to picture innovation activities in Mexican services firms at a disaggregated level (in this case, at branch level). Most innovation studies in services are made at sector level, regardless of the type

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of classification used. Furthermore, to take into account firms' technological bases in their innovative efforts, we complement this sectoral study by using Soete and Miozzo's technological trajectory framework in this study (Soete and Miozzo, 1990). We do this in order to compare national industry classifications and technological change approaches. Another motive for this dual perspective is that we consider innovation a cumulative and specific process, rather than a disembodied outcome (Gallouj, 2002). We therefore pose the following questions:

- Which sectors and branches of services in Mexico are most innovative, using the North American Industry Classification System (NAICS)²?
- Which sectors and branches of services in Mexico are most innovative, using Soete and Miozzo's technological trajectory approach?

Our analysis is based on data from the 2004 and 2009 Economic Censuses, which include a module of surveys on Innovation and Research using dichotomous (“yes” or “no”) questions. It is important to note that the two surveys are different: the 2009 survey has more questions than the 2004 survey, and many of these concern the use of Information and Communication Technologies (ICTs). Like most innovation studies, the surveys concentrate mainly on technological innovations. This is because they were first designed for manufacturing firms, and were just applied to service firms using the so-called “subordination approach” to service innovation (Djellal and Gallouj, 1999). However, we think this database offers certain benefits. First, since the data comes from censuses, it offers unparalleled coverage of most service firms in Mexico. Second, unlike traditional questionnaires, the survey's structure covers all types of innovation, including product and service innovations, process innovations, organisational innovations and external relationship innovations.

The study uses the methodology proposed in Ayyagari *et al.* (2011), although it has been adapted to the data available in Mexico. Over the period 2002-2004, these authors addressed innovation in emerging markets using a sample of 19,000 SMEs across 47 developing countries. It was focused on company level, without distinguishing between sectors.

2 NAICS' economic classification from highest to lowest is: sector, sub-sector, branch, sub-branch, class.

In addition to individual indicators of innovation activities, they analysed two aggregate indices: “Core Innovation” and “Aggregate Innovation”.

This article is divided into four sections. The first reviews the relevant service innovation literature, and the second describes the database and methodology. The third section analyses innovation sectors and branches, using both the The North American Industry Classification System (NAICS) and the Soete and Miozzo technological trajectories approach. In the final section, we summarize and discuss the results.

1. SERVICE INNOVATION AND TECHNOLOGICAL TRAJECTORIES TAXONOMY

1.1 SERVICE INNOVATION

Economists see innovation and technological change as crucial elements of economic growth and development (Schumpeter, 1942; Solow, 1957; Griliches, 1986; Fageberg, 1988; Freeman, 1994; Silverberg and Soete, 1994; Freeman and Soete, 1997; Griliches, 1998; Baumol, 2002; Aghion and Durlauf, 2005; Ayyagari *et al.*, 2011). Up until now, services have largely been considered technologically backward, with innovation playing no role in the aggregate performance of these sectors (Cainelli *et al.*, 2006). However, Gallouj (2002) contends that in services, non-technological innovations and innovation trajectories (such as cognitive trajectories) are as important as technological trajectories.

For Gallouj (2002, see also Gallouj and Weinstein, 1997), there are three approaches to literature on innovation in services:

1. The technologist or subordination (or assimilation) approach equates or reduces innovation in services to the introduction of technical systems into services firms and organisations
2. The service-oriented (or demarcation) approach seeks to identify any particularities in the nature and organisation of innovation in services
3. The integrative or synthesis approach favours a similar analytical approach to innovation in goods and services

Compared with the primary and manufacturing sectors, services exhibit certain peculiarities: the product is a process; it is not only intangible and impossible to store, but also “nebulous” and extremely heterogeneous. Furthermore, it is interactive, which means that service customers and providers collaborate in the design, production and delivery of the service, and production and consumption are simultaneous (Gallouj, 2002; Miles, 2005; Castellacci, 2008).

The use of advanced ICTs has enabled the creation of new service delivery mechanisms, reducing the time required to develop and introduce new services. The service sector is a heavy user of these technologies, and the economic impact of such technologies is more visible in this sector (Cainelli *et al.*, 2006)³.

Although technology is important, other forms of innovation (non-technological product/service and process innovations, organisational innovation, methodological innovations, etc.) are equally important. And if the service company does have an innovation department (which is not the case for most), its actors are seldom alone in the innovation process. They are almost always supplemented by (and in competition with) formalised though non-permanent innovation structures (project groups made up of people from different departments) - particularly in knowledge-intensive activities featuring a high level of informal encounters among its stakeholders (Sundbo, 1998; Fuglsang, 2008; Djellal and Gallouj, 1999, 2001; Gallouj and Djellal 2010).

In conclusion, it can be said that services do innovate significantly, though differently from manufacturing sectors (Miles *et al.*, 1994; Sundbo, 1998; Djellal and Gallouj (1998) and Gallouj, 2002). Taking account of the distinctive features of services requires a multidisciplinary approach that involves organisational behaviour, social networks, marketing, strategy and communication (Tether and Howells, 2007).

1.2 TAXONOMIES OF TECHNOLOGICAL TRAJECTORIES

Many innovation studies have focused on the technologist approach. Surveys originally designed for use by manufacturing firms were thus also used by service firms (Djellal and Gallouj, 1999), despite the fact

3 According to Miles (1995), around 80% of IT investment is consumed by the service sector in the United Kingdom and the United States.

that they were ill-equipped to accommodate the realities of innovations in services (Gallouj, 2002).

In order to identify the main sources and characteristics of technological change in economic sectors, as well as its economic impacts, various taxonomies have been proposed: Freeman, 1982; Pavitt, 1984; Freeman and Soete, 1987, 1997; Mills, 1986; Lakshmanan, 1987; Pavitt *et al.*, 1989; Soete and Miozzo, 1990; Miozzo and Soete, 2001; Gallouj, 1999).

Pavitt's (1984) seminal work uses a range of criteria and characteristics, including sources of technology, types of user and user needs, innovation appropriation regimes, size of company, degree of technological diversification and others. He divided the economy into four categories, each representing a sectoral model of technical change: supplier dominated firms; scale-intensive firms; specialised suppliers, and science-based firms. Services are included only in the case of "supplier dominated firms" – although non-market services were not taken into account (Gallouj, 2002).

Soete and Miozzo (1990) rejected the hypothesis (supported by some authors) that technological behaviour in the service sector was homogeneous. Their taxonomy uses Pavitt's criteria, yet does not consider services to belong to any single category. Soete and Miozzo's taxonomy includes three types of firms and industries:

1. Firms "dominated by suppliers" of equipment and technical systems. These firms' innovative activities consist of adopting the technologies of industrial suppliers, and can be subdivided into two groups:
 - 1.1 Personal services: small firms whose customers are sensitive to performance and whose modes of innovation appropriation are non-technological. These modes include professional know-how, aesthetic design, branding and advertising (*e.g.* repair services, cleaning, hotel and catering, retailing, laundry services).
 - 1.2 Public and social services: large firms and organisations whose customers are conscious of quality, but not in a stringent manner. Moreover, their innovations constitute public goods (*e.g.* education, health and public administration).
2. "Network firms": these follow a trajectory characterised by cost reduction and implementation of a networking strategy. They tend to be sizeable firms, and their main modes of innovation appropriation

are through standards and norms. Their customers are extremely price sensitive. These firms may turn to outside suppliers for their technologies, but always do so from a position of strength. They can be subdivided into two groups by principal means of service delivery:

- 2.1. Physical networks: firms whose services are based on tangible resources (e.g. transport, wholesale trade).
- 2.2. Informational networks: Codified information is the means of service delivery (e. g. finance, insurance, and communications).
3. “Specialised suppliers and science-based services”: These are characterised by small firms whose technological trajectory is based on system design. Their clients are more concerned with technology performance than cost, while the innovation appropriation regime is dominated by R&D know-how, copyright and product differentiation. The source of technology can be in-house, customer or supplier (e.g. service providers having particular relationships to R&D, information technologies and telecommunications).

However, in both of these taxonomies (Pavitt, and Soete and Miozzo), the technological trajectory alone is considered. Yet in services, other (non-technological) trajectories play an important role. These other trajectories may be cognitive (based on the improvement of competences), methodological, data processing, social or organisational (Gallouj, 2002).

2. DATABASE AND ANALYSIS METHODOLOGY

The study is based on 2004 Census⁴ data from 13 sectors and 96 branches and 2009 Census⁵ data from 12 sectors and 64 branches. The analysis counts the number of affirmative responses linked to innovation

4 Sectors 48-49, which correspond to Transportation and Warehousing, are excluded from this census.

5 Sectors 55 and 62, which correspond to Management of Firms and Enterprises and Health care and Social assistance, respectively, are excluded from this census. The number of questions for the 2009 Census was increased and it used the “Open Innovation” approach, defined as “Deliberate use of inputs and outputs of knowledge to accelerate internal innovation, and expanding the use of innovation markets respectively” (Chesbrough, 2006),

activities made by firms (see Table 1 for the 2004 Census, which includes ten questions, and Table 2 for the 2009 Census, which includes 21 questions). Those responses are codified as dichotomous variables (Yes = 1, No = 0). Next, they are grouped at sector and branch levels. The percentages thus obtained are used to construct the indices for the study. It should be noted that these censuses do not include firm level data⁶, but they do provide branch level responses. The indices are therefore constructed from the percentages for each sector and branch.

The questions in these tables are classified by innovation type: Product and Service Innovations (PSI), Process Innovations (PI), Organisational Innovations (OI) and External Relationship Innovations (EI). A single activity (question) can encompass several innovation types.

In addition to census questions, we created two aggregate indices of innovation: “Core Innovation” and “Aggregate Innovation” (constructed according to the methodology proposed by Ayyagari, *et al.*, 2011). The “Aggregate Innovation” index measures the total number of responses linked to innovation activities, whereas the “Core Innovation” index counts only those responses linked to activities considered basic or essential to the development of product or service innovations. The “Core Innovation” index includes three questions (1, 2 and 6) from the 2004 Census and two questions (1 and 5) from the 2009 Census. The “Core Innovation” index could express a “technologist view” in which services are seen as unsuited to R&D and innovation (see Gallouj and Djellal (2010) for a critique of this position). For this reason, we consider results for this indicator to be technologically biased. Nevertheless, we use it to contrast results with the “integrative view” of the “Aggregate Innovation” index.

The values for the aggregate indices are constructed by adding up the percentages of affirmative responses for each classification. We find these indices to be useful for indicating which sectors or branches are most innovative. In all cases, high values for these indices reflect high levels of innovation. The maximum values for “Aggregate Innovation” indices in the 2004 and 2009 Censuses are ten and twenty-one, respectively; the maximum values for “Core Innovation” indices in the 2004 and 2009 Censuses are three

with an emphasis “on the way to use, manage, apply and also to generate intellectual property” (Herzog, 2008). Besides, this census has more questions on the use of ICTs.

6 Company-level data are not available for reasons of confidentiality, but also for certain variables of some branches and sectors. This is in accordance with the law of the National System of Statistical and Geographical Information, in articles 37, 38, 42 and 47.

and two, respectively. The minimum value for all cases is zero. For all the innovation activities indices, we have created tables for both classification level and census (a detailed description is found in Zagaceta-García, 2016). We also include Soete and Miozzo's classification codes (See Appendix, Tables 1A-4A). However, it is important to note that due to methodological differences, it is difficult to make comparisons between censuses (due to the differing number of questions for each census, confidentiality problems, and the incompatibility of different versions of NAICS).

TAB. 1 – Questions on innovation activity in Mexican firms, 2004 Census.

Code	Question	Innovation type code
1	Had a department dedicated total or partially to the design or creation of new products or processes.	PSI, PI
2	Invested in the creation of new products, materials, devices or components.	PSI
3	Registered products or other works of intellectual creation to intellectual property institutes.	PSI, PI
4	Trained staff in the use of new technologies and work processes.	PI, OI
5	Implemented processes of reorganization in working systems.	PI, OI
6	Adapted their goods or services to changes in the preferences of their customers.	PSI
7	Used computer equipment in administrative processes.	PI
8	Used the internet in their relationships with customers and suppliers.	EI
9	Used computer equipment in technical processes or design.	PI
10	Developed programs or software packages to improve their processes.	PI

Source: based on economic census of Mexico, 2004.

Notes: Each question is classified by the type of innovation: PSI (product and service innovations), PI (process innovations), OI (organizational innovation), EI (external relationship innovations). "Core Innovation" index includes questions 1, 2 and 6.

TAB. 2 – Questions of innovation activity in Mexican firms, 2009 census.

Code	Question	Innovation type code
1	Had specialized areas dedicated to the design and creation of new products or services, production processes or provision of services.	PSI, PI
2	Registered or transacted patents of trademarks, products or processes.	PSI, PI
3	Hired or acquired patents of trademarks, products or processes.	PSI, PI, EI
4	Made collaboration agreements with research centers, universities and consulting firms.	EI
5	Made research for innovation.	PSI
6	Hired companies to do engineering research.	EI
7	Developed patents of trademarks, products or processes.	PSI, PI
8	Due to lack of resources stopped planning innovative projects or ceased to find substitutes that failed.	PSI, PI
9	Qualified full time staff dedicated to find solutions or improvements in quality control.	PSI, PI, OI
10	Qualified full time staff dedicated to find solutions or improvements in production processes efficiency.	PSI, PI, OI
11	Qualified full time staff dedicated to find solutions or improvements in innovation of products, services or processes.	PSI, PI, OI
12	With regular use of computer equipment.	PI
13	With regular use of the Internet.	PI, EI
14	Used communication networks: broadband internet.	PI, EI
15	Used communication networks: intranet.	PI
16	Used communication networks: extranet.	PI, EI
17	Made by internet: banking and financial operations.	EI
18	Made by internet: procedures with government.	EI
19	Made by internet: purchase or sale of products or services.	EI
20	Made by internet: information search.	EI
21	Made by internet: management activities for the firm (planning, organization, direction and control).	PI

Source: based on economic census of Mexico, 2009.

Notes: Each question is classified by the type of innovation: PSI (product and service innovations), PI (process innovations), OI (organizational innovation), EI (external relationship innovations). "Core Innovation" index includes questions 1 and 5.

Lastly, we analyse the responses for Mexican firms' innovation activities at the sector and branch levels, using Soete and Miozzo's taxonomy (see classification codes in Table 3). For the final part of the study, we use only the aggregate indices ("Aggregate Innovation" and "Core Innovation"). First, for each census, we obtain the average percentage of those indices at sector and branch levels. Second, we use Soete and Miozzo's categories to classify sectors and branches. Third, for each category we choose the sectors and branches having value greater than or equal to the average aggregate indices. Finally, we calculate the category's percentage of innovation (in all cases higher percentages correspond to higher degrees of innovation).

It is important to point out that in the case of "Network firms", we find it difficult to distinguish physical networks from informational networks. This sector and these branches have therefore been catalogued as "Network firms"⁷.

TAB. 3 – Classification codes based on Soete and Miozzo's taxonomy.

Code	Type
DS	Dominated by suppliers
PER	Personal services
PUB	Public and Social services
N	Network firms
PN	Physical networks
IN	Informational networks
SC	Specialized suppliers and science-based services

Source: based on Soete and Miozzo (1990) taxonomy.

7 The sector is Administrative and Support and Waste Management and Remediation Services for both censuses. The branches are: Retail trade in supermarkets; Retail trade in department stores; Parks with recreational facilities and electronic gaming also for both censuses. "Ambulances, organ banks and other ancillary services to medical treatment" for the 2004 Census and "Foreign package delivery services" for the 2009 census.

3. RESULTS

The results for the sector level analysis (2004 Census), show that Sector 51 (Information) has the greatest number of innovation activities, with an “Aggregate Innovation” index of 5.78 while Sector 72 (Accommodation and food services) has the lowest, at 1.37. The “Core Innovation” index (representing the use of “core” innovation activities) shows that Sector 52 (Finance and insurance) is the highest performer with an index of 1.81. The lowest innovator is again Sector 72, at 0.65. Meanwhile, the activities performed most across all sectors fall under “Adapted their goods or services to changes in the preferences of their customers” (PSI innovation type) and “Trained staff in the use of new technologies and work processes” (PI and OI types). The least performed activity is “Registered products or other works of intellectual creation to intellectual property institutes” (PSI and PI types). This tells us that different forms of innovation are present in services, though some service characteristics render a contrast with manufacturing difficult.

For the sector level analysis (2009 Census), Sector 52 (Finance and insurance) is most innovative, with an “Aggregate Innovation” index of 11.68, while the least innovative sector (as in the previous census) is Sector 72, at 3.83. Sector 52 (Finance and insurance) again has the highest “Core Innovation” index, and the lowest is once again Sector 72. In this census, the most common activity performed is “Made by Internet: information search” (EI type). The least performed are “Hired or acquired patents of trademarks, products or processes” (PSI, PI and EI types), “Hired firms to do engineering research” (EI type) and “Developed patents of trademarks, products or processes” (PSI and PI types).

Branch level analysis (2004 Census), shows that Branch 5151 (Transmission of radio and television programmes, except via the internet) has the highest “Aggregate Innovation” index, with Branch 5172 (Cellular and other wireless telecommunications, except satellite services) coming in second place. Branch 7213 (Pensions and guest houses, apartments and houses furnished with hotel services) has the lowest “Aggregate Innovation” index. Branch 5172 (Cellular and other wireless telecommunications, except satellite services) has the highest

“Core Innovation” index, with Branch 5151 (Transmission of radio and television programmes, except via the internet) in second place. These two branches switch places on the “Aggregate Innovation” index, and this result is consistent with the sector analysis, with Sector 51 (Information) rated the most innovative.

It is interesting to note that Branch 7222 (Self-service restaurants and with food to take-out) came in fourth place, with Branch 5415 (Computer consultancy services) coming in fifth. Once more, Branch 7213 has the lowest index. Interestingly, Branch 6219 (Ambulances, organ banks and other ancillary services to medical treatment) ranks very low. The analyses from the 2004 Census for branches thus show behaviour quite similar to that revealed in the innovation activity analysis at the sector level, in the 2004 and 2009 censuses.

Lastly, branch level analysis (2009 Census) shows that Branch 5221 (Multiple banking) scored the highest “Aggregate Innovation” index, Branch 5241 (Institutions of insurance and bonding) in second place. And Branch 4872 (Tourist transport by water) scored lowest. Branch 5221 again scored highest on the “Core Innovation” index and Branch 5241 came in second place on the “Aggregate Innovation” index. Branch 4852 (Non-urban collective fixed route passenger transportation) had the lowest index. The activity most performed for almost all branches is question number 20 (“Made by internet: information search”, EI type).

For the second part of the study, we drew up Table 4 (2004 Census) and Table 5 (2009 Census) to analyse the degree of innovation at both sector and branch levels, using Soete and Miozzo’s taxonomy.

Table 4 (2004 Census) shows the degree of innovativeness using Soete and Miozzo’s taxonomy, subdivided into sector level and branch level. In our analysis of the “Aggregate Innovation” index at sector level, we found (as do most innovation studies) that the most innovative firms belong to the “Specialised suppliers and science-based services” trajectory, with 100% of these sectors having a value that is greater or equal to the average. The second most innovative sector is “Network firms” with 66.7%. The least innovative sector is “Supplier-Dominated” firms with 16.7%. The “Personal services” category innovates more in core activities than “Public and Social services” does (25% vs. 0%, respectively).

At branch level, the various categories innovate as they do at sector level, although the percentages show less dispersion, no branch has scores

at 100% or 0%. Furthermore, we can see that all “Network firms” and “Specialised suppliers and science-based services” groups have more types of innovation (in both “Aggregate Innovation” and “Core Innovation” indices) than “Dominated by suppliers” firms.

TAB. 4 – Innovation in Mexican services sectors and branches
(Soete and Miozzo’s taxonomy), 2004 Census.

Sector level (13 sectors)	Sections with more or equal value than aggregate average	“% of Aggregate Innovation”	Sections with more or equal value than core average	“% Core Innovation”
	Average Index = 3.3		Average Index = 1.10	
Dominated by suppliers	1	16,7	1	16,7
Personal services	0	0,0	1	25,0
Public and Social services	1	50,0	0	0,0
Network firms	1	66,7	4	66,7
Physical networks	0	0,0	0	0,0
Informational networks	3	100,0	3	100,0
Specialized suppliers and science-based services	1	100,0	1	100,0

Branch level (96 branches)	Branches with more or equal value than aggregate average	“% of Aggregate Innovation”	Branches with more or equal value than core average	“% Core Innovation”
	Average Index = 3.49		Average Index = 1.10	
Dominated by suppliers	7	17,9	13	33,3
Personal services	2	6,7	7	23,3
Public and Social services	5	56,6	6	66,7
Network firms	26	60,5	21	48,8
Physical networks	15	57,7	12	46,2
Informational networks	9	69,2	7	53,8
Specialized suppliers and science-based services	11	78,6	10	71,4

Source: based on economic census for Mexico (2004) and Soete and Miozzo taxonomy (1990).
Notes: The figures correspond to the obtained category percentage for sectors or branches with major or equal value against “Aggregate Innovation” or “Core Innovation” sector and branch averages respectively. Higher percentages are consistent to higher degrees of innovation.

Table 5 (2009 Census) also uses Soete and Miozzo’s taxonomy to show the degree of innovativeness. In the “Aggregate Innovation” index at sector level, the ranking among categories is the same as it was in 2004: “Specialised suppliers and science-based services” are the most innovative (100%), followed by “Network firms” (66.7%) and “Supplier Dominated” firms (20%). In addition, “Personal services” still scores 0%, as it did in 2004, whereas “Physical networks” go from 0% to 33.3%. “Public and Social services” increase from 50% to 100%. With the exception of “Personal services”, all categories increased their aggregate score. In terms of the “Core Innovation” index, “Network firms” seem less innovative than they were in 2004 (50% vs. 66.7%).

At branch level, ranking in terms of innovativeness is maintained. As with 2004 Census, there is less dispersion at the branch level.

TAB. 5 – Innovation in Mexican services sectors and branches
(Soete and Miozzo's taxonomy), 2009 census.

Sector level (12 sectors)	Sectors with more or equal value than aggregate average	"% of Aggregate Innovation"	Sectors with more or equal value than core average	"% Core Innovation"
	Average index = 7.26		Average index = 0.30	
Dominated by suppliers	1	20	1	20
Personal services	0	0	0	0
Public and Social services	1	100	1	100
Network firms	4	66,7	3	50
Physical networks	1	33,3	1	0
Informational networks	1	100	0	100
Specialized suppliers and science-based services	2	100	2	100

Branch level (64 branches)	Branches with more or equal value than aggregate average	"% of Aggregate Innovation"	Branches with more or equal value than core average	"% Core Innovation"
	Average index = 7.34		Average index = 0.30	
Dominated by suppliers	5	31,3	4	25
Personal services	3	21,4	2	14,3
Public and Social services	2	100	2	100
Network firms	26	66,7	13	33,3
Physical networks	14	56	5	20
Informational networks	10	100	7	70
Specialized suppliers and science-based services	8	88,9	8	88,9

Source: based on economic census for Mexico (2009) and Soete and Miozzo taxonomy (1990).
Notes: The figures correspond to the obtained category percentage for sectors or branches with major or equal value against "Aggregate Innovation" or "Core Innovation" sector and branch averages respectively. Higher percentages are consistent to higher degrees of innovation.

CONCLUSION

In this paper, we have extended innovation studies to the service sector in developing countries. As the share of services in these countries' GDP approaches that of developed countries, the service innovation topic is gaining in prominence. We used data from the 2004 and 2009 Economic Censuses of Mexico to identify which sectors and branches are most innovative in this country. We compared innovation in Mexican firms using both the North American Industry Classification System (NAICS) and Soete and Miozzo's technological trajectories mapping.

The results of the first part of the study (using NAICS) indicate that all service sectors innovate. Service sectors traditionally seen as "the most innovative" (Information, Finance and Insurance, Professional, Scientific and Technical Services) are still ahead, undertaking the bulk of innovation-related activities, according to the two surveyed censuses. Breaking down sectors into branches allows a closer view of how innovation activities are distributed, with some branches appearing more

innovative than the sectors they belong to. Branch level analysis is thus more accurate than sector level analysis.

By analysing how Mexican firms innovate, we found that firms tend to underexploit certain actions, such as “Registered products or other works of intellectual creation to intellectual property institutes”. This finding is in agreement with the conventional innovation surveys conducted to capture technological innovations, rather than the intrinsic characteristics of services. For the 2009 census, another underused category is “Activities with the involvement of other external agents or external relationship innovations”. This can be attributed to firms’ lack of confidence to explore the potential of the Open Innovation approach.

It should be observed that in developing countries like Mexico, “service firms collaborate with customers and suppliers more than through in-house R&D” according to Tether’s (2005) study on European countries.

Moreover, Mexican firms in all sectors and branches state that they include an innovation department. However, due to the specificities of services, we infer that many of these departments are in fact flexible project groups or “innovation structures” – as Djellal and Gallouj (1999) called them – rather than permanent physical areas.

Though the use of computer equipment and the internet is considered essential to services innovation specifically, the responses to questions 7 to 10 (2004 Census) and 12 to 21 (2009 Census) show that this kind of equipment is not broadly used in all sectors and branches. Nevertheless, in the 2009 Census, we can see extensive use of ICTs by most firms, although different firms may use them differently.

Lastly, using Soete and Miozzo’s mapping, we were able to confirm that the most innovative sectors and branches are “Specialised suppliers and science-based services” followed by “Network firms”, while the least innovative are those labelled as “Supplier Dominated”. In any case, contrary to the assertions of the technologist/assimilation approach, we found the service sector to be heterogeneous in terms of its innovative activities (Gallouj, 2002). We therefore advocate for analyses that are both finer, and more disaggregated, to portray service firms’ innovations more accurately.

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APPENDIX

1A. Sector level innovation indices (NAICS), 2004 census

Soete and Miozzo's code	Sector	Description	"Core Innovation" (max value= 3)	"Aggregate Innovation" (max value= 10)
PN	43	Wholesale trade	0,92	3,09
PER	46	Retail trade	0,99	2,37
IN	51	Information	1,74	5,78
IN	52	Finance and Insurance	1,81	5,11
PN	53	Real Estate and Rental and Leasing	0,68	2,06
SC	54	Professional, Scientific and Technical Services	1,26	4,11
IN	55	Management of Companies and Enterprises	1,20	4,83
N	56	Administrative and Support and Waste Management and Remediation Services	1,14	3,90
PUB	61	Educational Services	1,08	3,65
PUB	62	Health Care and Social Assistance	1,04	2,76
PER	71	Arts, Entertainment, and Recreation	1,13	2,49
PER	72	Accommodation and Food Services	0,65	1,37
PER	81	Other Services (except Public Administration)	0,71	1,74

Source: based on economic census for México (2004) and Soete and Miozzo's taxonomy (1990).

Notes: Sector 48-49 (Transportation and Warehousing) is not included in the 2004 census. "Administrative and Support and Waste Management and Remediation Services" sector has been catalogued like "Network firms" instead of separate it into the two groups from Soete and Miozzo's taxonomy.

"Physical networks" or "Informational networks". "Core Innovation" index includes questions 1, 2 and 6. The averages for the "Core Innovation" and

"Aggregate Innovation" indices are 1.10 and 3.33, respectively.

2A. Branch level innovation indices (NAICS), 2004 census (continued)

Soete and Miozzo's code	Branch	Description	"Core Innovation" (max value= 3)	"Aggregate Innovation" (max value= 10)
PN	4311	Wholesale trade of grocery and food	0,85	2,99
PN	4312	Wholesale trade of beverages and tobacco	0,96	3,72
PN	4321	Wholesale trade of textile products and footwear	0,99	3,00
PN	4331	Wholesale trade of pharmaceutical products	1,11	4,22
PN	4332	Wholesale trade of perfumery and jewelry items and other clothing accessories	1,10	3,25
PN	4333	Wholesale trade of discs, toys and sporting goods	1,44	3,90
PN	4334	Wholesale trade of stationery, books, magazines and newspapers	1,02	3,92
PN	4335	Wholesale trade of minor household appliances and white goods	1,10	3,80
PN	4341	Wholesale trade of agricultural raw materials	0,89	2,48
PN	4342	Wholesale trade of raw materials for industry	0,91	2,96
PN	4343	Wholesale trade of waste materials	0,63	1,67
PN	4351	Wholesale of machinery and agricultural, forestry and fishing equipment	0,85	3,50
PN	4352	Wholesale trade of machinery and equipment for the industry	0,90	3,98
PN	4353	Wholesale trade of machinery and equipment for services and commercial activities	1,09	4,24
PN	4354	Wholesale trade of machinery, furniture and general-use equipment	1,11	4,53
PN	4361	Wholesale trade for trucks	1,28	5,07
PN	4371	Intermediation to the wholesale trade	1,13	4,70
PER	4611	Retail trade for food	0,79	1,63
PER	4612	Retail trade of beverages and tobacco	0,73	1,52
N	4621	Retail trade in supermarkets	1,20	3,94
N	4622	Retail trade in department stores	1,45	5,26
PER	4631	Retail trade of textile products, except clothing	0,67	1,82
PER	4632	Retail trade of clothing and clothing accessories	1,18	2,47
PER	4633	Retail trade of footwear	0,90	2,23
PER	4641	Retail trade of health care articles	1,05	2,83
PER	4651	Retail trade of perfumery and jewelry	0,86	2,51
PER	4652	Retail trade for recreation articles	1,33	3,01
PER	4653	Retail trade of stationery, books and newspapers	1,09	2,48
PER	4659	Retail trade of pets, gifts, religious items, crafts, articles in importing stores and other personal items	0,85	1,87
PER	4661	Retail trade of home furniture and other household appliances	0,97	2,80
IN	4662	Retail trade of computers, phones and other communication devices	1,02	3,58
PER	4663	Retail trade of interior decoration items	0,92	2,14
PER	4671	Retail trade for hardware stores and glass	0,92	2,42
PN	4681	Retail trade for cars and light trucks	1,18	3,84
PER	4682	Retail trade of spare parts for cars, light trucks and trucks	0,87	2,51
PER	4684	Retail trade of fuels and lubricating oils	0,80	2,90
IN	5111	Edition of newspapers, magazines, books and the like, except via the Internet	1,81	5,88
SC	5121	Film and video industry	0,94	4,46
SC	5122	Sound industry	1,13	4,28
SC	5151	Transmission of radio and television programmes, except via the Internet	2,14	6,99
SC	5172	Cellular and other wireless telecommunications, except satellite services	2,19	6,92
SC	5175	Cable television programmes, except via the Internet	1,41	4,85
SC	5181	Internet access and search online services	1,81	5,85
SC	5182	Electronic processing of information, hosting of web pages and other related services	1,51	5,94
IN	5224	Brokerage credit and financial services not stock exchange	0,79	2,10
IN	5239	Other investment and brokerage services	1,94	6,68
IN	5241	Institutions of insurance and bonding	1,41	6,15
PN	5311	Rent without intermediation of dwellings and other real state	0,57	1,39
PN	5312	Real estate and real estate brokers	0,65	3,03
PN	5324	Rental of industrial, commercial and services machinery and equipment	1,07	3,37
IN	5411	Legal services	0,90	3,12

Source: based on economic census for Mexico (2004) and Soete and Miozzo taxonomy (1990).

(Continued)

Notes: Sector 48-49 (Transportation and Warehousing) is not included in the 2004 census. "Retail trade in supermarkets"; "Retail trade in department stores"; "Ambulances, organ banks and other ancillary services to medical treatment"; "Parks with recreational facilities and electronic gaming" branches have been catalogued like "Network firms" instead of separate them into the two groups from Soete and Miozzo's taxonomy; "Physical networks" or "Informational networks". "Core Innovation" index includes questions 1, 2 and 6. The averages for "Core Innovation" and "Aggregate Innovation" indices are 1.10 and 3.49, respectively.

2A. Branch level innovation indices (NAICS), 2004 census

Soete and Miozzo code	Branch	Description	"Core Innovation" (max value= 3)	"Aggregate Innovation" (max value= 10)
IN	5412	Accounting, audit and related services	1,11	4,49
IN	5413	Services in architecture, engineering and related activities	1,16	4,69
SC	5415	Computer consultancy services	1,83	6,64
SC	5416	Administrative, scientific and technical consulting services	1,06	4,84
SC	5417	Scientific research and development services	1,44	5,52
SC	5418	Advertising services and related activities	1,69	4,84
SC	5419	Other professional, scientific and technical services	1,25	3,11
PN	5511	Corporate management and business	1,20	4,83
IN	5611	Business management services	1,06	3,14
PN	5612	Facilities support services	0,89	2,63
IN	5613	Employment services	1,05	3,24
IN	5614	Support service of secretarial, photocopying, collection, credit research and similar activities	1,03	4,18
PER	5615	Travel agencies and reservation services	1,29	3,72
PER	5616	Research, protection and safety services	1,34	3,84
PER	5619	Other support business services	1,07	2,92
PER	5621	Wastes management and remediation services	0,95	3,18
PUB	6111	Schools of basic, secondary and special education	0,99	3,47
PUB	6112	Career and Technical Schools	1,80	5,13
PUB	6113	Professional degrees and graduated schools	1,63	6,02
IN	6114	Commercial schools, computer and training for executives	1,60	5,60
PUB	6116	Other educational services	1,23	3,38
PUB	6117	Education support services	1,43	4,11
PUB	6211	Medical consulting offices	0,62	2,01
IN	6215	Medical and diagnostic laboratories	1,29	3,70
N	6219	Ambulances, organ banks and other ancillary services to medical treatment	0,33	2,14
PUB	6221	General hospitals	1,10	3,57
PUB	6223	Hospitals in other medical specialties	1,19	3,73
PER	6232	Homes for the care of people with mental retardation, mental health and substance abuse problems	1,00	2,91
PUB	6241	Guidance and social work services	0,94	1,71
PER	7113	Sponsors of artistic shows, sports and the like	0,81	2,53
PN	7121	Museums, historical sites, botanical gardens and the like	1,52	3,99
N	7131	Parks with recreational facilities and electronic gaming	0,94	1,80
PN	7139	Other recreational services	1,19	2,79
PER	7211	Hotels, motels and the like	0,42	1,67
PER	7213	Pensions and guest houses, apartments and houses furnished with hotel services	0,12	0,34
PER	7221	Restaurants with waiter service	1,28	2,60
PN	7222	Self-service restaurants and with food to take-out	1,85	3,53
PER	7223	Custom-made food preparation services	1,12	3,10
PER	8111	Repair and maintenance of automobiles and trucks	0,91	2,10
SC	8112	Repair and maintenance of electronic equipment and precision equipment	0,95	2,71
SC	8113	Repair and maintenance of agricultural, industrial, commercial and services machinery and equipment	0,98	2,67
PER	8122	Laundries and dry cleaners	1,12	2,57
PER	8124	Parking lots for cars	0,22	0,60
PER	8131	Commercial, industrial, recreational and professional organizations and associations	0,64	2,26
PER	8132	Religious, political and civil organizations and associations	0,44	1,68

Source: based on economic census for Mexico (2004) and Soete and Miozzo taxonomy (1990).

Notes: Sector 48-49 (Transportation and Warehousing) is not included in the 2004 census. "Retail trade in supermarkets"; "Retail trade in department stores"; "Ambulances, organ banks and other ancillary services to medical treatment"; "Parks with recreational facilities and electronic gaming" branches have been catalogued like "Network firms" instead of separate them into the two groups from Soete and Miozzo's taxonomy: "Physical networks" or "Informational networks". "Core Innovation" index includes questions 1, 2 and 6. The averages for "Core Innovation" and "Aggregate Innovation" indices are 1,10 and 3,49, respectively.

3A. Sector level innovation indices (NAICS), 2009 census

Soete and Miozzo's code	Sector	Description	"Core Innovation" (max value= 2)	"Aggregate Innovation" (max value= 21)
PN	43	Wholesale trade	0,23	7,64
PER	46	Retail trade	0,14	6,76
PN	48-49	Transportation and Warehousing	0,10	4,16
IN	51	Information	0,43	8,86
IN	52	Finance and Insurance	0,88	11,68
PN	53	Real Estate and Rental and Leasing	0,17	6,83
SC	54	Professional, Scientific and Technical Services	0,42	8,02
N	56	Administrative and Support and Waste Management and Remediation Services	0,30	7,93
PUB	61	Educational Services	0,41	8,21
PER	71	Arts, Entertainment, and Recreation	0,22	6,51
PER	72	Accommodation and Food Services	0,10	3,83
PER	81	Other Services (except Public Administration)	0,20	6,68

Source: based on economic census for Mexico (2009) and Soete and Miozzo taxonomy (1990).

Notes: Sectors 55 Y 62 (Management of Companies and Enterprises and Health Care and Social Assistance, respectively) are not included in the 2009 census. "Administrative and Support" and "Waste Management and Remediation Services" sectors have been catalogued like "Network firms" instead of separate it into the two groups from Soete and Miozzo's taxonomy: "Physical networks" or "Informational networks". "Core Innovation" index includes questions 1 and 5. The averages for the "Core Innovation" and "Aggregate Innovation" indices are 0.30 and 7.26, respectively.

4A. Branch level innovation indices (NAICS), 2009 census (continued)

Soete and Miozzo's code	Branch	Description	"Core Innovation" (max value= 2)	"Aggregate Innovation" (max value= 21)
PN	4311	Wholesale trade of grocery and food	0,21	6,98
PN	4312	Wholesale trade of beverages and tobacco	0,30	7,91
PN	4321	Wholesale trade of textile products and footwear	0,29	7,57
PN	4331	Wholesale trade of pharmaceutical products	0,29	8,26
PN	4333	Wholesale trade of discs, toys and sporting goods	0,31	8,29
PN	4334	Wholesale trade of stationery, books, magazines and newspapers	0,32	8,03
PN	4341	Wholesale trade of agricultural raw materials	0,27	7,52
PN	4342	Wholesale trade of raw materials for industry	0,20	7,49
PN	4352	Wholesale trade of machinery and equipment for the industry	0,11	8,02
PN	4353	Wholesale trade of machinery and equipment for services and commercial activities	0,31	8,96
PN	4354	Wholesale trade of machinery, furniture and general-use equipment	0,26	8,75
PER	4611	Retail trade for food	0,11	4,99
N	4621	Retail trade in supermarkets	0,17	5,53
N	4622	Retail trade in department stores	0,40	7,91
PER	4632	Retail trade of clothing and clothing accessories	0,21	5,67
PER	4641	Retail trade of health care articles	0,15	5,27
PER	4652	Retail trade for recreation articles	0,17	6,34
PER	4661	Retail trade of home furniture and other household appliances	0,14	6,32
IN	4662	Retail trade of computers, phones and other communication devices	0,28	8,28
PER	4671	Retail trade for hardware stores and glass	0,15	6,61
PN	4681	Retail trade for cars and light trucks	0,17	8,96
PER	4682	Retail trade of spare parts for cars, light trucks and trucks	0,13	6,72
PER	4684	Retail trade of fuels and lubricating oils	0,09	6,60
PN	4841	General freight trucking	0,10	5,24
PN	4842	Specialized freight trucking	0,07	4,17
PN	4851	Urban and suburban collective transport of passengers from fixed-route	0,09	2,84
PN	4852	Non-urban collective fixed route passenger transportation	0,07	2,85
PN	4871	Tourist transport by land	0,16	4,45
PN	4872	Tourist transport by water	0,15	2,02
PN	4885	Intermediation services for freight transport	0,26	8,98
N	4921	Foreign package delivery services	0,23	6,65
IN	5111	Edition of newspapers, magazines, books and the like, except via the Internet	0,41	8,91
SC	5151	Transmission of radio and television programmes, except via the Internet	0,43	8,35
SC	5171	Wireline telecommunications operators	0,48	9,12
SC	5172	Cellular and other wireless telecommunications, except satellite services	0,46	9,39
IN	5221	Multiple banking	1,30	13,51

Source: based on economic census for Mexico (2009) and Soete and Miozzo taxonomy (1990).

(Continued)

Notes: Sectors 55 Y 62 (Management of Companies and Enterprises and Health Care and Social Assistance, respectively) are not included in the 2009 census.

"Retail trade in supermarkets"; "Retail trade in department stores"; "Foreign package delivery services"; "Parks with recreational facilities and electronic gaming" branches have been catalogued like "Network firms" instead of separate them into the two groups from Soete and Miozzo's taxonomy; "Physical networks" or "Informational networks".

"Core Innovation" index includes questions 1 and 5. The averages for the "Core Innovation" and "Aggregate Innovation" indices are 0.30 and 7.34, respectively.

4A. Branch level innovation indices (NAICS), 2009 census

Soete and Miozzo code	Branch	Description	"Core Innovation" (max value= 2)	"Aggregate Innovation" (max value= 21)
IN	5224	Brokerage credit and financial services not stock exchange	0.62	10.35
IN	5241	Institutions of insurance and bonding	1.00	12.43
PN	5311	Rent without intermediation of dwellings and other real state	0.13	5.52
PN	5312	Real estate and real estate brokers	0.21	7.29
PN	5324	Rental of industrial, commercial and services machinery and equipment	0.17	7.39
IN	5411	Legal services	0.25	7.91
IN	5413	Services in architecture, engineering and related activities	0.40	8.96
SC	5414	Specialized design	0.43	7.79
SC	5415	Computer consultancy services	0.84	10.84
SC	5416	Administrative, scientific and technical consulting services	0.40	8.96
SC	5418	Advertising services and related activities	0.55	8.79
SC	5419	Other professional, scientific and technical services	0.24	5.74
IN	5611	Business management services	0.32	8.46
PN	5612	Facilities support services	0.34	8.34
IN	5613	Employment services	0.28	7.58
PER	5615	Travel agencies and reservation services	0.29	7.64
PER	5616	Research, protection and safety services	0.34	8.47
PER	5619	Other support business services	0.38	8.76
PUB	6111	Schools of basic, secondary and special education	0.35	7.99
PUB	6113	Professional degrees and graduated schools	0.60	9.47
IN	6114	Commercial schools, computer and training for executives	0.40	7.67
N	7131	Parks with recreational facilities and electronic gaming	0.26	5.93
PN	7139	Other recreational services	0.20	7.00
PER	7211	Hotels, motels and the like	0.10	3.81
PER	7221	Restaurants with waiter service	0.23	6.34
PN	7222	Self-service restaurants and with food to take-out	0.08	2.46
SC	8113	Repair and maintenance of agricultural, industrial, commercial and services machinery and equipment	0.33	8.42
PER	8131	Commercial, industrial, recreational and professional organizations and associations	0.16	6.11

Sources: based on economic census for Mexico (2009) and Soete and Miozzo taxonomy (1990).

Notes: Sectors 55 Y 62 (Management of Companies and Enterprises and Health Care and Social Assistance, respectively) are not included in the 2009 census.

Retail trade in supermarkets; *Retail trade in department stores*; *Foreign package delivery services*; *Parks with recreational facilities and electronic gaming* branches have been catalogued like "Network firms" instead of separate them into the two groups from Soete and Miozzo's taxonomy; *Physical networks* or *Informational networks*.

Core Innovation index includes questions 1 and 5. The averages for the *Core Innovation* and *Aggregate Innovation* indices are 0.30 and 7.34, respectively.