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International niche market leaders as drivers of industrial districts: a value chain perspective

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Abstract Research on Industrial Districts (IDs) as spatial and regional economic phenomena has led to the development of various classification schemes aimed at distinguishing different types of IDs. However, these typologies have largely overlooked the presence and role of International Niche Market Leaders (INMLs). This gap prompts an important question: do IDs that host INMLs fit within existing classifications, or do they require adjustments or extensions to current frameworks?

To explore this issue, we analyze two Spanish IDs and demonstrate that INMLs can indeed be embedded within these districts. Notably, INMLs may occupy either upstream or downstream positions in the value chain, and the segments they inhabit often play a critical role in shaping the technological trajectory and internationalization dynamics of the ID. Although leadership within IDs is traditionally attributed to downstream producers, our findings reveal that upstream suppliers can also be central to the district's development.

These insights allow us to refine existing ID typologies by incorporating the role of INMLs. We argue that the relationship between IDs and INMLs is potentially symbiotic: while IDs can nurture the emergence of INMLs, these firms, in turn, can significantly contribute to the evolution and competitiveness of the districts. Based on this perspective, we offer a set of policy recommendations.

Keywords Industrial districts · International niche market leaders · Regional clusters · Hidden champions · Value chains

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1 Introduction

Industrial districts (IDs) are geographically concentrated buyer-supplier networks linked to specific industries (Becattini 2002). Despite globalization and the offshoring of many industrial activities, several European localities still display high levels of sectoral specialization (Giuliani and Rabellotti 2017; Asheim 2024), maintaining the relevance of IDs as both a theoretical and empirical construct.

International niche market leaders (INMLs) are firms that focus on narrow product lines and operate in specialized industrial market spaces. They are typically among the top three global players in their field or are market leaders on a particular continent (Kamp 2017), akin to "hidden champions" (Simon 2009). From a value chain perspective on IDs (Carbonara et al. 2002), INMLs may be producers of finished goods (occupying downstream positions from a value chain viewpoint) or suppliers of key inputs (in that case they occupy upstream positions).

Although both IDs and INMLs have attracted academic and policy interest, no prior research has explored their intersection. Thus, whether INMLs can be integral parts of IDs remains an open question. Moreover, while INMLs are often recognized as important regional actors, previous studies have approached regions mainly as administrative units rather than from the perspective of IDs. This raises further questions: is the (international or technological) development of INMLs aligned with that of the IDs to which they belong? And can their presence help identify which (downstream or upstream) segments within an ID are most dynamic?

Research on IDs has produced classification schemes—most notably Markusen (1996)—to differentiate types of IDs based on structural traits. However, these schemes did not account for the presence and role of INMLs. It is therefore worth investigating whether IDs hosting INMLs align with existing types or call for extensions or refinements to these classifications.

To address these questions, we analyze two Spanish IDs. We find that INMLs can indeed be part of IDs, and that they can form part of either the upstream or downstream segments of such districts. Moreover, the segments they inhabit often play a pivotal role in setting the technological and internationalization trajectory of the ID. While ID leadership is typically attributed to downstream producers, our research shows that upstream suppliers can also drive their development—a finding that challenges conventional perspectives in ID literature.

By unpacking Markusen's typology into its structural characteristics and comparing these to IDs with INML presence, we enrich the profile of existing ID types and propose new ones. This enhances the taxonomical range of the typology and extends its applicability.

Our study contributes to four strands of literature. First, it enriches research on INMLs and their spatial-economic embeddedness. In line with studies on German and Italian hidden champions—focusing on their location within administrative units (Benz et al. 2021), proximity to universities (Schenkenhofer et al. 2024), or co-

location with other niche leaders (Lehmann et al. 2025)—we add another meso-level perspective by examining Spanish INMLs within IDs.

Second, we contribute to the debate on agglomeration advantages by focusing on INMLs as contributors to the vitality of their industrial environments (Benz et al. 2021), rather than mere beneficiaries. By comparing INMLs to their ID peers, we reason how they can propel internationalization and technological development within the district.

Third, we extend the literature on ID leadership and strategic direction (Albino et al. 1999; Carbonara et al. 2002; Munari et al. 2012; Bacchiocchi et al. 2014). Contrary to the common view that leadership resides in downstream producers, we show that upstream segments—characterized by a superior innovation and international orientation—can also serve as engines of ID development.

Fourth, our work advances research on ID classification and transformation (Markusen 1996; Giuliani and Rabellotti 2017; Bellandi and De Propris 2017). By dissecting the structural characteristics of IDs and evaluating our cases accordingly, we propose a refined typology that captures a broader range of ID configurations and evolutionary paths.

The remainder of this article is structured as follows. Section 2 reviews the existing literature and introduces the research questions. Section 3 describes the methodology and data sources used to address these questions. Section 4 presents the research findings. Section 5 discusses these findings and outlines their conceptual and policy implications. Finally, Sect. 6 highlights the study's limitations and offers directions for future research.

2 Literature review and research questions

2.1 International niche market leaders as part of industrial districts

A priori, it is logical to assume that INMLs can emerge from or thrive within Industrial Districts. For instance, Audretsch et al. (2021) suggest that hidden champions are the result of localized specialization profiles, whether industrial or technological. Similarly, Asheim (2024, p. 137) notes that Industrial Districts demonstrating resilience in the face of globalization tend to be those with technologically advanced production and specialized products targeting niche markets. While he emphasizes that most IDs are found in Italy, he also observes that their evolution toward technologically sophisticated businesses focused on niche applications closely mirrors the development path of many German hidden champions. Accordingly, he draws a "personality" parallel between IDs and INMLs, while also highlighting that existing research addressing both phenomena remains fragmented, including from a geographical point of view.

To date, scholarly work on IDs and INMLs has remained largely disconnected. As a result, evidence of INMLs operating within industrial districts—and the nature of their relationship—is, at best, indirect. Indeed, researchers have begun to explore potential synergies between INMLs and their surrounding environments. For instance, Schenkenhofer et al. (2024) found a positive relationship between the

innovation performance of Italian hidden champions and their proximity to universities. Lehmann et al. (2025) concluded that innovation performance among German and Italian niche market leaders benefits from proximity to other hidden champions. Benz et al. (2021) also reported a positive correlation between the density of hidden champions across German NUTS-3 regions and regional economic performance.

Conversely, other studies present a more nuanced picture. Vonnahme and Lang (2021) and Rietmann (2021) found that hidden champions located in rural areas of Germany tend to derive limited benefit from their surrounding regional innovation systems. Rammer and Spielkamp (2015) similarly note that hidden champions have low regional sales, indicating a limited dependence on local clients—an observation also made by Simon (2009). Overall, the evidence regarding the benefits of local environmental relationships for INMLs remains mixed. Notably, none of the existing studies take industrial districts as their regional unit of analysis. Instead, they typically rely on administrative boundaries, regional innovation systems, university-firm linkages, or the co-location of niche market leaders.

A similar situation can be observed in Spain, where research into both IDs (Belso-Martinez 2006; Hervas-Oliver et al. 2015; Molina-Morales et al. 2017) and INMLs (Kamp 2017, 2018, 2019A; Kamp and Ruiz de Apodaca 2023) has grown over the past decade. This disconnect likely stems from the fact that clusters and IDs have been approached mainly from spatial and geographical perspectives, while International Businesses—including INMLs—have primarily been studied within the domains of business and management (Hervas-Oliver 2015; Hervas-Oliver et al. 2020).

2.2 INMLs and propulsion of iDs

To address the challenges of globalization and continuous innovation (Bronzini et al., 2013), industrial districts that aim to remain internationally competitive tend to thrive thanks to firms that connect them to external demand and keep them at the forefront of (sophisticated) technological development in the products and applications they offer. Access to global sales and R&D pipelines is thus crucial (Giuliani and Rabellotti 2017; Belussi 2018; Asheim 2024).

In this context, IDs have often been depicted as value chain constellations where downstream firms—those producing finished goods—lead the district both commercially and technologically (Albino et al. 1999; Carbonara et al. 2002; Munari et al. 2012; Bacchiocchi et al. 2014). Or in terms of introducing new knowledge into the district (Buciuni and Pisano 2018) or by taking the 'go-no go' decisions regarding (radical) innovations that permeate the district (Hervás-Oliver et al. 2018). For the internationalization of sales and the absorption of global knowledge, these end product manufacturers are generally expected to guide the IDs as well (Belussi 2018).

Particularly in IDs exposed to intense globalization pressures—where integration into global value chains (GVCs) was necessary or unavoidable—downstream lead firms have tended to assume dominant roles (Buciuni and Pisano 2018). As a result, the prevailing view is that IDs are typically driven by downstream actors.

Interestingly, INMLs may occupy either downstream or upstream positions within value chains. Downstream INMLs produce or integrate high-end finished goods or provide custom solutions (Simon 2009; Rammer and Frietsch 2015), while upstream INMLs supply specialized inputs for those goods and solutions (Venohr and Meyer 2007). From a value chain perspective, this implies that downstream INMLs are expected to steer the development of the district, whereas upstream INMLs would rely on leading firms at the apex of the ID to drive progress.

Although scholars have shown that INMLs often play a significant role in the regional environments and districts where they are located (Audretsch et al. 2021b; Benz et al. 2021; Rietmann 2021), existing studies have not assessed their relevance specifically within the framework of IDs as regional economic phenomena. Furthermore, these studies have not examined the positions that INMLs occupy within local value chains—whether downstream or upstream.

2.3 Typologies to classify ID types

Research on industrial districts (IDs) has produced various classification schemes that distinguish them based on structural characteristics. Among these are the typologies proposed by Giuliani and Rabellotti (2017) and Bellandi and De Propris (2017). However, the most well-known and widely applied is the typology developed by Markusen (1996). Her classification differentiates IDs according to firm size (SMEs vs. large firms), ownership (local vs. foreign), market structure (few or many suppliers and buyers within the ID and corresponding sourcing practices), and the degree of dependence between upstream and downstream firms—both in terms of sales, for supplier, and purchasing, for buyers—that form part of an ID.

Markusen (1996) also considers the locus of leadership within the district, particularly from technological and internationalization perspectives. Consistent with the views of several scholars (Albino et al. 1999; Carbonara et al. 2002; Munari et al. 2012; Bacchiocchi et al. 2014; Belussi 2018; Buciuni and Pisano 2018), she assumes that IDs tend to be propelled by downstream firms. This downstream leadership may originate either within or outside the focal district. Based on these dimensions, Markusen identifies three primary types of IDs: the Marshallian Industrial District, the Hub-and-Spoke District, and the Satellite Platform District. Syntheses of these three ID types are presented in Table 1.

2.4 Research questions

Although perspectives on the relationship between INMLs and their (industrial) environment are limited, fragmented, and often inconclusive, no dedicated empirical research has yet been conducted to verify the presence of INMLs within industrial districts (IDs). Consequently, the question of whether INMLs (can) form part of IDs remains to be addressed (Research Question 1).

Another question that has yet to be assessed is the extent to which the predominant presence of INMLs in either the upstream or downstream segment of an ID can serve as an indicator of which segment propels the district e.g. from a technological and international business development perspective (Research Question 2)?

Table 1 Schematic characterizations of industrial districts based on Markusen's typology. (Source: own elaboration.)

	Producers of finished goods with a downstream position			Suppliers with an upstream position			Market structure	International Business development	Technological development
	Typical size	Origin of ownership	Reliance on local suppliers for purchasing	Typical size	Origin of ownership	Reliance on local buyers for sales			
Marshallian industrial district	Small or medium-sized	Local	High[1]	Small or medium-sized	Local	High	Many buyers, many/myriad suppliers Multiple sourcing	Downstream propulsion[2]	Downstream propulsion[3]
Hub-and-spoke district	Large	Local	Moderate[4]	From small or medium-sized (local suppliers) to large (suppliers from outside the ID)	Local or foreign	Moderate[5]	Single/few buyers, selected (few) suppliers Single/dual sourcing	Downstream propulsion[6]	Downstream propulsion[7]
Satellite platform district	Large	Foreign	Reduced[8]	Large	Largely foreign	Reduced[9]	Single/few buyers, selected (few) suppliers Single/dual sourcing	External propulsion[10]	External propulsion[11]

[1] Most inputs are obtained on an intra-ID basis: locally integrated value chain model
[2] Producers of finished goods take the lead in targeting foreign markets, sometimes operating through export consortia
[3] Assisted by specialized support structures, like R&D centers, within the district
[4] Substantial intra-district trade among dominant firms and suppliers, complemented with substantial links to suppliers outside the ID
[5] Higher for local suppliers than for suppliers from outside the ID
[6] Local hub firms as trailblazers of internationalization for other local district members, but not for suppliers from outside the ID
[7] Specialized sources for technical expertise and new knowledge are largely dominated by downstream firms ("buyers as knowledge tractors"), although suppliers from outside the ID may also rely on own resources in this regard
[8] Minimal intra-district trade among buyers and suppliers
[9] Idem
[10] Main actors making up Satellite Platform Districts (SPDs) form part of multinational enterprises, and as such SPDs and affiliated firms are already members of IB networks
[11] Main sources for technical expertise and new knowledge are provided from outside the ID (mainly through resources at headquarters of foreign mother companies)

Finally, since the foundational research underlying existing ID typologies—such as Markusen (1996)—did not consider the presence of INMLs within industrial districts, it is pertinent to appraise whether IDs that host INMLs can be classified within the existing typology, or whether Markusen's framework requires a broadening or refinement of its taxonomic categories to accommodate such cases (Research Question 3)?

3 Methods and data

3.1 International niche market leaders as part of industrial districts

To address Research Question 1—whether INMLs can be part of IDs—we proceed as follows.

To encounter ID-INMLs constellations, we combine data on IDs across Spain from Boix et al. (2015) and an inventory of Spain-based INMLs from the Basque Institute of Competitiveness (2020). Boix et al. (2015) inventorize geographical areas across Spain in which the economy relies chiefly on manufacturing activities. Next, they establish concentration quotients of employment and enterprises pertaining to different industrial subsectors in these geographical areas. The industrial subsector on which a geographical area obtains the highest concentration quotient (and provided this score is higher than 1, which represents the national average per sector), is considered the dominant branch of activity of the ID encountered there. Since the measurement protocols of Boix et al. (2015) focus explicitly on SMEs (e.g. more than 50% of the employment has to take place in enterprises with less than 250 employees), their method leads particularly to the detection of Marshallian IDs.

Based on company surveys and desk-research, the Basque Institute of Competitiveness (2020) inventory maps INMLs that meet the following criteria: manufacturing-focused companies selling primarily in B2B markets, leading their niche in Europe or ranking among the global top three by market share, generating at least 50% of revenue from international sales, and having an annual turnover below €1 billion.

By overlaying the INML inventory onto the map with industrial districts (IDs), constellations of ID-INMLs emerge, enabling us to assess whether this phenomenon occurs in the Spanish context. Regarding the identified constellations, we describe the composition of their upstream (suppliers) and downstream (producers of finished goods/buying companies) segments, and indicate the specific segments to which the INMLs belong.

3.2 INMLs and propulsion of iDs

To address Research Question 2—can the predominant presence of INMLs in either the upstream or downstream end of an ID be indicative of which segment drives the district e.g. from a technological and international business development perspective?—we proceed as follows.

To assess international business development, we calculate weighted export ratios (exports as a percentage of turnover) for the upstream and downstream segments of the industrial districts (IDs) under analysis. Additionally, we examine whether firms in each segment have manufacturing subsidiaries abroad as a means of expanding international business, and whether these foreign plants are located in key sales markets for the district.

For technological development, we analyze patenting activity during the 21st century in both upstream and downstream segments of the IDs. When available, we also use R&D expenditure (as a percentage of turnover) as a complementary indicator for each segment. Finally, we assess whether the most significant inventions per ID were developed by firms in the upstream or downstream segment.

Depending on the number of firms in each segment, we either construct representative samples—when the number is manageable and sufficient data is available—or use aggregated data from key sub-sectors when sampling is impractical or data is unavailable.

For sampled segments, firms are selected based on membership lists from sectoral associations and cross-checked with SABI[1] to identify the largest firms per segment. These samples aim to represent the majority share of segment employment, ensuring adequate coverage. Export data for these firms is sourced from SABI. When sampling is not feasible, we use regional input-output tables and information from regional sector federations to obtain export data for the most representative sub-sectors. Information on foreign production plants is gathered through company websites and direct consultations. The commercial importance of foreign markets is assessed using sectoral reports.

Patent data for sampled firms is obtained from the European Patent Office's Espacenet. We calculate patent-to-employee ratios to compare patenting intensity across segments and between upstream and downstream components. For unsampled segments, we rely on EPO patent-intensity indicators for relevant sub-sectors.[2] R&D expenditure data is sourced from the relevant sector associations. Finally, we identify which inventions have served as key precedents in the industry's competitive evolution, and determine whether the corresponding patents were primarily filed by upstream or downstream firms.

Based on the former analyses, we evaluate whether the internationalization and technological innovation performance of the segment to which most INMLs pertain stands out positively amidst the ID that they form part of. Accordingly, and as an input to answering Research Question 3, we assess which (downstream or upstream) segment appears as the main propulsor for international business and technological development of the IDs under scrutiny. We posit that this role is fulfilled by the segment that patents the most technological inventions, and exhibits the strongest internationalization through export and production abroad.

[1] The Iberian Balance Sheet Analysis System; the Spanish/Portuguese version of Bureau Van Dijk's Amadeus database.

[2] https://euipo.europa.eu/tunnel-web/secure/webdav/guest/document_library/observatory/documents/reports/IPR-intensive_industries_and_economic_in_EU_2022/2022_IPR_Intensive_Industries_FullR_en.pdf.

3.3 Classifying iDs that host iNMLs from a markusen typology perspective

To appraise whether IDs hosting INMLs can be classified as one of the ID types from the Markusen (1996) typology (Research Question 3), we characterize the IDs to be analyzed on the basis of the structural elements from Table 1. Data for the corresponding assessments stems from the following sources.

To determine the average size (in terms of annual turnover and employment) of the respective upstream and downstream segments from the IDs to be screened, we use data from regional statistics bureaus, regional sector associations and we look at individual company data—reported to SABI—for the different segment-specific firm samples. To assess the share of large firms versus SMEs among these segments, we take the EC definition of SMEs as the point of reference.[3]

Information on local or foreign ownership is gathered through thematic reports on foreign firms published by regional Chambers of Commerce,[4] as well as press releases—particularly those concerning mergers and acquisitions—related to the companies from the industrial districts under study and, more broadly, to their respective segments.

To establish the reliance of downstream (buyer) firms on local suppliers and the reliance of upstream (supplier) firms on local buyers, we use regional input-output tables to assess the importance of local purchasing for producers of finished goods inside the IDs to be analyzed. Similarly, these input-output tables serve to assess the importance of local sales for supplier firms pertaining to the IDs to be analyzed. To give further relief to this structural element, we consulted with individual firms and reviewed their websites to obtain information on their local purchasing and sales patterns.

As regards the market structure of the IDs to be analyzed, data on the number of buyer and supplier firms inside each ID is obtained from regional statistics bureaus and regional sector associations. We talk of "few" (buyers or suppliers) when the number of firms stays within the dozen, of "several" when the number falls between 12 and 50, of "many" when it falls between 50 and 100, and "myriad" when it supersedes the 100 mark.

To assess whether the IDs to be analyzed are chiefly propulsed downstream or upstream for their international business development and technological advancement, we make use of the results from the analyses for Research Question 2 (see under § 3–2).

Consequently, we judge whether the IDs under scrutiny show fit with any of the ID types from the Markusen typology, or whether this typology could benefit from a broadening or refinement of its taxonomical variety. Table 2 summarizes how each research question will be addressed.

[3] Large firms report more than 50 million euros annual turnover and employ more than 250 persons. Small firms stay below 10 million euros annually and 50 employees. Medium-sized firms fall between the upper limits of the small firm metrics and the lower limits of the large firm metrics. https://single-market-economy.ec.europa.eu/smes/sme-fundamentals/sme-definition_en.

[4] I.e., https://www.camaracastellon.com/uploads/cms_files/Internacionalizacion/Informe%20Empresas%20Exportadoras%20Castellon.pdf.

Table 2 Research questions and their corresponding methods and data. (Source: own elaboration.)

Research question	Method	Data sources
1: Can INMLs form part of IDs?	Combining inventories of IDs and INMLs across Spain to see whether INML-ID constellations emerge	Boix et al. (2015) Basque Institute of Competitivenes (2020)
2: Can the predominant presence of INMLs in either the downstream or upstream end of an ID be indicative of which segment propels it from a technological and international business perspective?	Comparing export and FDI performance across downstream and upstream segments of IDs Comparing patenting performance and expenditure of R&D across upstream and downstream segments of IDs Invention impact appraisal Assess which segment reveals superior performance	Export data: SABI, regional input-output tables, regional sector association Locations of foreign production subsidiaries: individual company websites and direct consultations Patent data: EPO R&D expenditure: regional sector associations Qualitative assessment
3: Can IDs hosting INMLs be classified as one of the ID types from the Markusen typology?	Characterize IDs on the basis of the following structural elements: – Producers of finished goods with a downstream position: Typical size, Origin of ownership, Reliance on local suppliers for purchasing – Suppliers with an upstream position Typical size, Origin of ownership, Reliance on local buyers for sales – Market structure – Propulsion of International Business development – Propulsion of technological development Determine whether the subsequent profiles correspond with any of the base ID types from the Markusen typology	Size data: SABI, regional statistics bureaus, regional sector associations Ownership data: sector studies as from Chambers of Commerce, specialized press reports Reliance on local suppliers or buyers: regional input-output tables from regional statistical bureaus, individual company consultations Market structure: regional statistics bureaus, regional sector associations Propulsion of International Business development: findings from RQ 2 Propulsion of technological development: findings from RQ 2

4 Results

4.1 International niche market leaders as part of industrial districts

Boix et al. (2015) identify 151 IDs in Spain. Most of them are located along the Mediterranean coast (forming part of the autonomous communities of Catalonia and Valencia), and along the Ebro basin (roughly between Cantabria and Southern Catalonia).

A study by the Basque Institute of Competitiveness (2020) paints a similar picture. Based on a total of 112 INMLs identified (three quarters of which are SMEs), this

inventory reveals how the Burgos province and the Basque Country (south and east of Cantabria), Navarra, the province of Zaragoza, central Catalonia and Castellón (Northern part of Valencia) shelter important concentrations of these firms.

Combining the two inventories results in Fig. 1.

In Fig. 1, two INMLs-ID constellations stand out.[5] The first is the collection of yellow dots on a blue font in Castellón, along the Mediterranean coast. It corresponds to the ceramics industry (ϵ 03 household goods). The second is formed by a series of green dots on a grey font, representing the Basque Country and its metalworking machinery industry (ϵ 06 mechanical industry) in the Northern Central part of the map.

In what follows, we present further details on both constellations.

4.1.1 Castellón ceramics district

Industrial ceramics production in Castellón dates to the early 18th century. Boix et al. (2015) refer to the Castellón ceramics district as the canonical Spanish example of an ID, as approximately 95% of Spain's ceramic production originates from Castellón. Its value chain can be portrayed as shown in Fig. 2.

The district has several support structures, starting with dedicated associations: ASCER for tile manufacturers, ANFFECC for frits, glazing, and colouring producers, and ASEBEC for ceramics machinery builders. The members of these associations generate an annual turnover that surpasses €7 billion, of which some €5 billion is generated by tile producers, around €1.8 billion by frits, glazes and colorant suppliers, and €0.4 billion by ceramics machinery manufacturers (see Tab. 7 in Supplementary Material). Together, they employ around 20,000 people, representing almost half of those working in Castellón's industrial sector (ibid).

The Castellón district also boasts public-private partnerships, such as the Technological Ceramics Institute (a specialized research, training, and testing center). Similarly, it has several schools and institutes specialized in the training of ceramics professionals.

Within this district, we find six INMLs (see Fig. 3). Four are manufacturers of frits, glazing and colouring products, and two are manufacturers of special-purpose ceramics machinery.

In value chain terms, the Castellonese INMLs are found at the upstream (supplier) end of the ceramics ID. On the one hand, there are Esmalglass, Ferro Spain, Gruppo Colorobbia, and Torrecid as suppliers of frits, glazing and colouring products. On the other, we have Kerajet and Cretaprint as producers of inkjet printers for ceramic applications.

[5] While several INML dots are also visible around the Barcelona Metropolitan area, this area is not retained for further analysis, as it is not categorized as an ID. Moreover, the INMLs in this area are from a diverse range of industries, so it does not form a coherent INMLs-ID constellation.

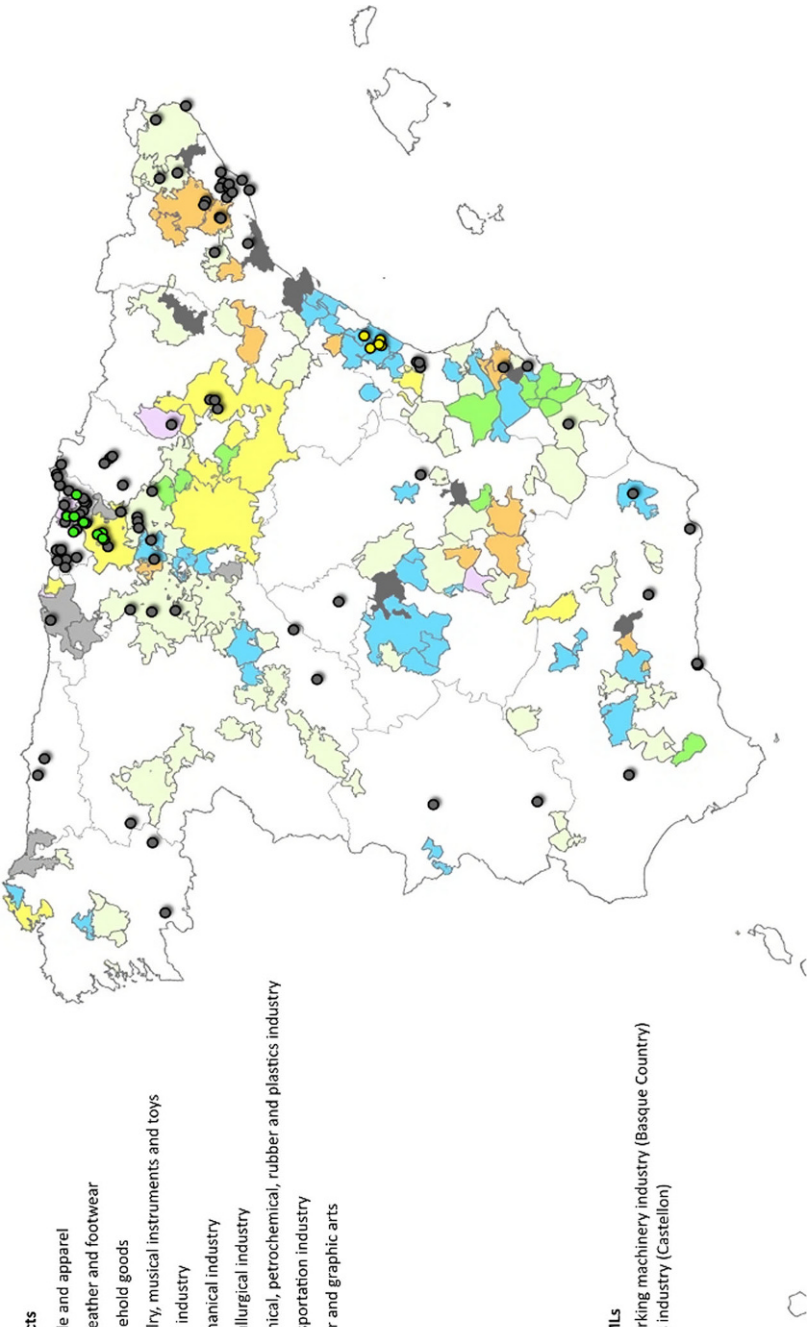

Fig. 1 Spread of INMLs and IDs across Spain. (Source: Boix et al. (2015) and Basque Institute of Competitiveness (2020))

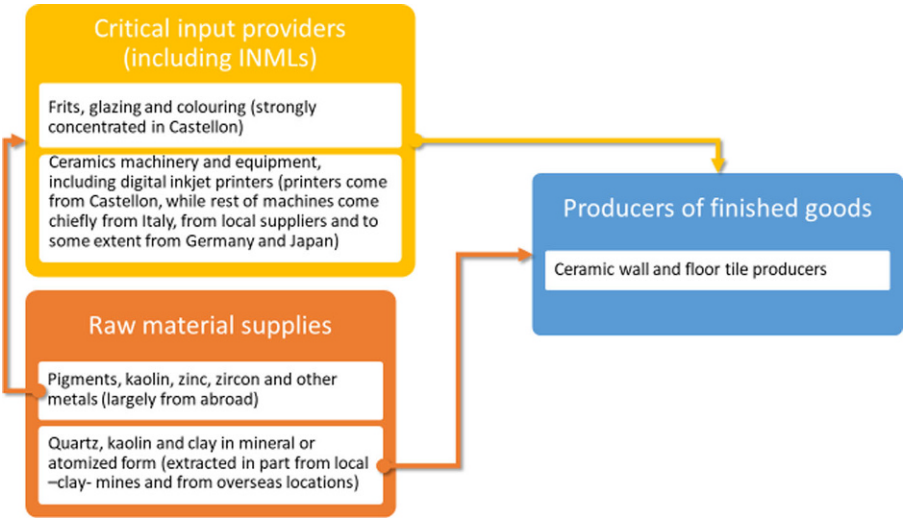

Fig. 2 Main upstream (left side) and downstream (right side) segments of Castellón ceramics district. (Source: own elaboration based on www.ANFFECC.es, www.ASCER.es, Membrado-Tena et al. (2019), Sales Saiz (2019))

Fig. 3 INMLs from the Castellón ceramics district. (Source: own elaboration)

4.1.2 Basque metalworking machinery district

Industrial machine tool building in the Basque Country dates to the late 19th century, ahead of most other parts in Spain. Over time, it developed into the heartland of Spanish machine tool production for metalworking (Valdaliso 2018). Today, around 80% of Spain's machine tool building activities for metalworking is in the Basque Country. Consequently, the sector's national trade association (AFM) is headquartered in San Sebastian. In the Basque Country, this activity generates an annual turnover of €3.4 billion (see Tab. 8 in Supplementary Material). Nearly €1 billion comes from producers of finished machines (ibid). In addition, the district includes a layer of suppliers of specialized components and electronic, optical, and digital equipment, which accounts for €1.4 billion annually (ibid). It is also supported by a wide network of firms dedicated to mechanization, engineering, and metal treatment, which generate approximately €1.2 billion per year (ibid). Altogether, this amounts to nearly 17,000 employees, representing almost 10% of those employed in the Basque industrial sector (ibid). Its value chain can be portrayed as shown in Fig. 4.

Furthermore, the Basque metalworking machinery district boasts a dedicated training institute (IMH) for machine tool building. Additionally, there are technology centers, like IDEKO, Lortek, Tecnalia and Tekniker that provide (R&D) services to the district's companies. Furthermore, there is intensive cooperation with local universities for applied lifelong learning and training programmes.

This district is home to nine INMLs (see Fig. 5): seven of them are manufacturers of metalworking machinery, while two are IT firms specialized in metal-machining applications.

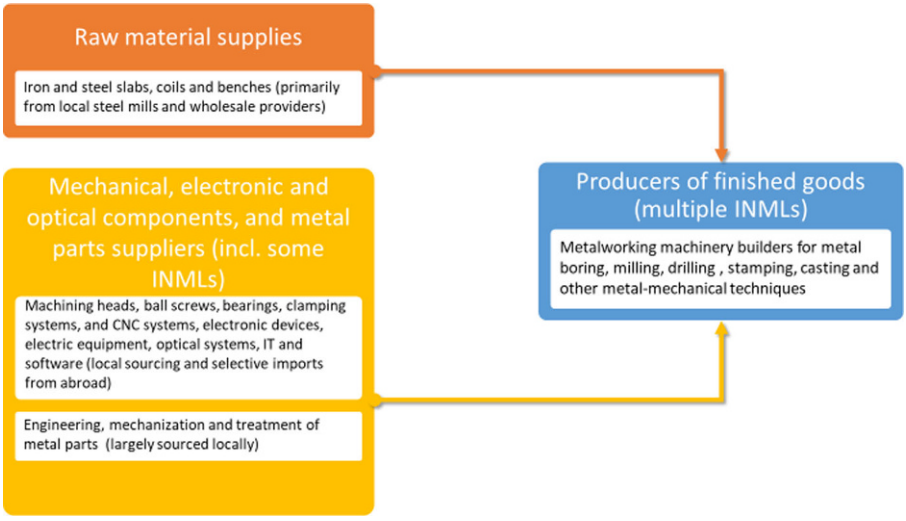

Fig. 4 Main upstream (left side) and downstream (right side) segments of Basque metalworking machinery district. (Source: own elaboration based on www.AFM.es and Zubiaurre et al. (2020))

Fig. 5 INMLs from the Basque metalworking machinery district. (Source: own elaboration)

In value chain terms, the INMLs are chiefly found at the downstream (buying) end of the Basque metalworking machinery district. Among the producers of finished machines, we find the following INMLs: Cevisa, Danobat, Etxe-Tar, Fagor Arrasate, Loramendi and Soraluce. In addition, as part of the upstream (supplying) part of this ID, there are two INMLs: Lantek (software for metal cutting) and Fagor Automation (linear and rotary measurement, as well as CNC systems for machine tools).

4.2 INMLs and propulsion of iDs

4.2.1 International business development

Castellón ceramics district The tile producers sample (see Tab. 9 in Supplementary Material) reveals that 58% of this segment's production value is exported. The corresponding ratio for the frits, glazing and colouring producers is 59% (ibid), while the INMLs from this segment reveal a weighted export ratio of 68%. In the case of the ceramics machinery segment, it is 47% (ibid). The latter ratio is based on a sample that includes the two inkjet printer INMLs, which derive 82.5% of their turnover from exports. Excluding these two firms, the weighted average for the ceramics machinery segment drops to 30%.

When it comes to serving markets through foreign production facilities, neither tile producers nor ceramic machinery manufacturers from Castellón have production centers abroad under their direct control. Conversely, owning production plants abroad is more common among the frits, glazing, and colouring producers—including its INMLs. Esmalglass and Torrecid have the widest manufacturing network abroad, counting with around a dozen foreign production plants each. These are notably located in the world's main tile producing countries,[6] like China, India, Brazil, Turkey, Italy, Indonesia and Vietnam. Ferro Spain also counts with produc-

[6] See: https://mahashankh.com/top-tiles-manufacturing-countries-in-2022-2024-world/.

tion plants in countries like China, Indonesia and Thailand. Another company worth mentioning is Fritta, with plants in Italy, India, Mexico and Vietnam, as well as Vidres, with plants in Italy and Portugal.

Thanks to their offshore production capacity, frits, glazing, and coloring producers generate a higher share of turnover from foreign markets than their export ratios alone would suggest. In some cases, the value of goods produced abroad exceeds half of what these companies export directly from their home base.

Basque metalworking machinery district While the sampled producers of finished machinery achieve a weighted export-to-turnover ratio of 87% (see Tab. 10 in Supplementary Material), this figure is lower for the supplier segments. According to regional input-output tables, manufacturers of specialized components and electronic, optical, and digital equipment derive approximately 40% of their turnover from exports (see Tab. 11 in Supplementary Material). The mechanization, engineering, and metal treatment segment shows a similar weighted export-to-turnover ratio (ibid).

As for the INMLs, the seven firms in the machine tool builder segment post a weighted export ratio of 89%, while the two INMLs from the supplier segment reach 87%.

Engaging in international business through the establishment of foreign production plants remains a minority practice within this ID. However, such practices are more prevalent among firms in the downstream segment. Machine-producing firms with manufacturing capacity abroad include INMLs such as ONA, which operates a factory in the United States, and Fagor Arrasate, which has facilities in China and Mexico. Danobat, another INML, maintains manufacturing centers across several European countries, including the United Kingdom, the Netherlands, Germany, Italy, and Romania.

Other producers of finished machines also operate foreign plants. For instance, Ibarmia and Lazpiur each maintain a facility in China, while Ekin operates plants in both India and Mexico.

Among component and subsystem suppliers, the presence of foreign production sites is even more limited. Exceptions include Fagor Automation—an INML, with a production site in China—and Egaña Metalocaucho, which operates a plant in India.

Although these foreign subsidiaries are generally modest in size—with the exception of Fagor Arrasate's plant in China—they contribute to increasing the share of foreign sales in total company turnover.

It is also worth noting that, aside from Danobat's facilities in the United Kingdom, the Netherlands, and Romania, the remaining foreign plants are located in countries that represent some of the most significant global markets for metalworking machinery.[7]

[7] chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.mta.org.uk/wp-content/uploads/2023/08/CECIMO-Global-Machine-Tool-Report-2022-May-23.pdf.

4.2.2 Technological development

Castellón ceramics district In the downstream tile-producing segment, the sample shows a ratio of 0.0024 patents per employee (see Tab. 9 in Supplementary Material). For the frits, glazing, and colouring producers segment, this ratio is ten times higher, at 0.024 (ibid). Within this segment, INMLs outperform their peers, reaching a ratio of 0.03, with Torrecid standing out as the most prolific filer, achieving 0.051 patents per employee. The ceramics machinery manufacturing segment displays an even higher average ratio of 0.068 (ibid). Interestingly, the two inkjet printing INMLs within this segment underperform, with a combined ratio of 0.033. This is mainly due to the absence of patenting activity by Cretaprint, while Kerajet surpasses the segment average, registering 0.077 patents per employee throughout the 21st century.

In terms of R&D expenditure as a fraction of turnover, the differences are less sharp as the tile producing segment spends on average 1.5% of its turnover on R&D, while the frits, glazing and colouring segment devotes 2% of its turnover on R&D across the board, including its INMLs. For the ceramics machinery segment no percentage could be established, while for the inkjet printing manufacturers the long-term average of R&D on turnover is close to 5%.

A closer examination of inventions by firms within this industrial district reveals the pioneering role of Torrecid and Esmalglass in the development of digital inks for the digital printing of ceramic tiles and slabs. This technological breakthrough has enabled tile manufacturers to produce more durable products with a wider variety of finishes and enhanced quality, thereby strengthening the competitiveness of downstream segments. In parallel, the Castellón-based subsidiary of Gruppo Colorobbia has developed phosphorescent and antimicrobial pigments, broadening both the aesthetic and functional applications of ceramic finishes. Likewise, Coloronda's innovation in wood-like glazing introduced unprecedented levels of warmth and thermal insulation to ceramic materials.

Moreover, inkjet producers from Castellón have been instrumental in the digital transformation of ceramic printing, both within this ID and globally. Their innovations have allowed for the precise and versatile application of advanced finishes, significantly expanding the aesthetic possibilities of tile design and facilitating the production of complex and customized patterns. While several other patents have been registered by firms in the ceramic machinery sector, these typically focus on the optimization of existing production processes rather than the introduction of disruptive innovations.

Basque metalworking machinery district During the 21st century, producers of metalworking machinery from the Basque Country have registered an average of 0.073 patents per employee (see Tab. 10 in Supplementary Material). Within this downstream segment, the seven machine tool builders identified as INMLs show a higher rate, averaging 0.12 patents per employee over the same period. Among them, Etxe-Tar and Loramendi stand out as the most inventive firms, with 0.19 and 0.33 patents per employee, respectively.

By comparison, the components and electronic, optical, and digital equipment segment is estimated—based on EPO data—to reach approximately two-thirds of

the patenting intensity of the metalworking machinery manufacturers (see Tab. 11 in Supplementary Material). The metal mechanization, engineering, and treatment segment exhibits a patent-per-employee ratio less than one-third of that of the metalworking machinery producers (ibid).

Within this upstream segment, the two INML firms report a fairly low, combined, ratio of 0.0094. This can be partly attributed to the absence of patenting activity by Lantek—a result that is not unusual, given that software programs are generally less likely to be patented. Meanwhile, Fagor Automation records a modest average of only 0.013 patents per employee throughout the 21st century.

In terms of R&D expenditure as a share of turnover, the downstream segment—comprising machinery manufacturers—invests an average of 5% of turnover in R&D, while its INMLs report a weighted average of 8%. In contrast, upstream suppliers allocate only 1.5% on average. Nevertheless, there is considerable variation within the supplier segment, as both INML firms report spending more than 10% of their revenues on R&D.

Several inventions from this district have marked significant breakthroughs for the metal-machinery industry by introducing functionalities that were previously nonexistent. Notable examples include Soraluce's stabilization systems, Danobat's anti-vibration devices, and Etxe-Tar's laser-based metal treatment methods. These innovations have set new standards in metalworking machinery, earning international recognition and awards for their contribution to advancing the state of the art. Similarly, ONA's patented filtering system—designed to eliminate the need for manual cleaning after metal debris accumulation—has significantly enhanced the productivity of electric discharge machines used in metal shaping. Loramendi, for its part, has pioneered the development of core-making machines for electric engines, establishing a technological first in this field.

In contrast, Basque component suppliers such as Fagor Automation, Fresmak, and Shuton tend to focus on incremental innovation within established functionalities. Their patents frequently aim to improve measurement accuracy, component durability, and operational reliability. Examples include Fagor Automation's optoelectronic encoders, Fresmak's pneumatic-hydraulic force intensifier, and Shuton's advancements in ball screw technology. While these inventions are essential for optimizing machinery performance, they are generally oriented toward enhancing existing systems rather than introducing disruptive applications. Consequently, component suppliers play a largely supportive role within the technological development hierarchy, prioritizing continuous improvements that meet the stringent requirements set by machine manufacturers.

4.3 Classifying iDs that host iNMLs from a markusen typology perspective

4.3.1 Market structure and firm size indications

Castellón ceramics district In this industrial district, the number of buyer firms exceeds that of the two supplier segments (see Tab. 3). Furthermore, the number of finished goods producers is notably high ("myriad"), while the number of suppliers is moderate ("several"). In certain cases, this asymmetry gives rise to oligopolistic

Table 3 Quantity and size indications of companies representing the upstream and downstream segments of the Castellón ceramics district. (Source: own elaboration based on data from ASCER, ANFFECC, ASEBEC and IVE.)

2022		Number of companies	Average turnover in M€ per company	Average number of employees per company
Downstream producers of finished goods	Ceramic tile manufacturers	97	54.9	150.2
Upstream segments	Frits, glazing and colouring product suppliers	22	82.2	187.2
	Ceramics machinery suppliers	38	13.1	47.4

dynamics, where virtually all tile producers source specific inputs from a limited number of suppliers. This is particularly evident in the case of inkjet printers, where only two manufacturers are present.

From a firm-size perspective, suppliers of frits, glazes, and coloring products surpass finished goods producers in terms of average employment and turnover. In contrast, the ceramics machinery segment comprises the firms with the smallest average size within the district.

When examining the distribution of large firms across segments, we find that 20% of the sampled tile producers qualify as large firms (see Tab. 9 in Supplementary Material), compared to 41% within the frits, glazing and colouring producers segment (ibid). All four INMLs in the latter segment are large firms, each with annual turnovers in the hundreds of millions of euros. In contrast, the ceramics machinery segment is predominantly composed of SMEs, with only 5% of the sampled firms classified as large (ibid). Among these firms is Cretaprint, the inkjet printing INML. Additionally, while the subsidiaries of Barbieri & Tarozzi Iberia (SITI Group) and System España (Coesia) located in Castellón are medium-sized firms, their parent companies are clearly large firms.

Basque metalworking machinery district The market structure of this industrial district is characterized by a large number of buyers and a multitude of suppliers. While the number of end-product manufacturers is substantial (“several”), Tab. 4 shows that it is clearly outnumbered by the highly numerous supplier firms (“myriad”). This configuration portrays the district as a large supplier ecosystem that offers a wide variety of inputs to a considerably smaller group of final product integrators. Overall, this structure provides ample opportunities for multiple sourcing or switching between suppliers. However, for certain specialty components, the range of available suppliers may be very limited.

In terms of firm size—measured by average employment and turnover—columns 4 and 5 of Tab. 4 show which values apply to the upstream and downstream firms operating within the district.

These data indicate that both metalworking machinery manufacturers and their suppliers are generally small in size, reflecting the SME-based nature of this industrial district. Specifically, only 7% of the sampled machine tool manufacturers

Table 4 Quantity and size indications of companies representing the upstream and downstream segments of the Basque metalworking machinery district. (Source: own elaboration based on data from Eustat and AFM.)

2022		Number of companies	Average turnover in M€ per company	Average number of employees per company
Downstream producers of finished goods	Metalworking machinery manufacturers	46	19.7	71.9
Upstream segments	Specialized component and electronic, optical, and digital equipment suppliers	151	8.7	35.4
	Mechanization, engineering, and metal-treatment suppliers	475	2.4	16.9

are classified as large firms (see Tab. 10 in Supplementary Material), and the share among the supplier segments is unlikely to be higher. Among the few large suppliers are Fagor Automation and the Basque subsidiary of the German firm Schaeffler. As a result, machinery manufacturers generally surpass component suppliers in terms of size.

However, firm size data for the INMLs in this district diverge significantly from these averages. Three of the seven INMLs in the downstream machine tool manufacturing segment are classified as large firms, and one of the two supply-side INMLs—Fagor Automation, as noted above—is also a large firm.

4.3.2 Company ownership characteristics

Castellón ceramics district In recent years, foreign ownership of firms has become an increasingly prominent phenomenon in this industrial district. However, significant differences exist across segments in terms of the share of foreign-controlled firms. According to the Castellón Chamber of Commerce, close to 20% of the local tile producers are currently under foreign ownership (see Tab. 12 in Supplementary Material), all as a result of acquisitions. Noteworthy examples are Saloni, Keraben, and Ibero (acquired by UK-based Victoria), Equipe Ceramicas (by Italy's Italcer), Roca, Belcaire, and Baldocer (by Mexico's Lamosa), Halcon (by Falcon Private Holdings—USA), Rocersa (by Avenue Capital—USA), and Neolith (by CVC—UK). Nevertheless, local ownership remains the dominant pattern among tile producers. Interestingly, some of the larger locally owned firms—such as Porcelanosa and Pamesa—have initiated the formation of conglomerates by incorporating smaller competitors from the Castellón area into their brand and product portfolios. Foreign ownership is more prevalent in the frits, glazes, and coloring products segment, with over half of the firms controlled by foreign entities (ibid), according to the Castellón Chamber of Commerce. This is attributable, on the one hand, to the establishment of subsidiaries by foreign companies in the Castellón area—such as the Italian firm Colorobbia—and, on the other, to the acquisition of local firms by foreign investors. In this regard, e.g. Esmalglass, Ferro Spain, Fritta, and Itaca ended

up in the hands of US investment fund Carlyle, while SICER and Smalticeram (both from Italy) acquired existing local companies in Castellón. In parallel, this segment has also witnessed the emergence of conglomerates formed around key local players. Notably, firms such as Torrecid and Vidres have incorporated local competitors into their holding structures.

The ceramics machinery segment within Castellón is largely made up of local firms, while it also counts with a handful of foreign-owned players. Like Cretaprint, which was acquired by Electronics for Imaging (USA), or System Ceramics (acquired by Coesia from Italy). In addition, Barbieri & Tarozzi, LB, and SACMI are examples of foreign (Italian) firms that opened their own subsidiaries in Castellón. In total, 16% of the ceramics machinery firms in Castellón are foreign-owned (see Tab. 12 in Supplementary Material), including the largest businesses in the segment. Moreover, given the high volume of imported ceramics machinery, it is important to note that a significant share of suppliers is located outside Castellón—particularly in Italy—and is, naturally, also under foreign ownership.

When it comes to the INMLs from this district, four out of six are now in the hands of foreign organizations. Only Torrecid and Kerajet remain locally owned.

Basque metalworking machinery district Local ownership remains dominant among companies in this district, both in the machinery manufacturing segment and among suppliers. Foreign firms with a local presence through greenfield investments are rare. The local facilities of the French machinery builder Dimeco and the German supplier Schaeffler stand out as notable exceptions. Acquisitions of local firms by foreign entities are also rare within the Basque metalworking machinery sector. One such exception is the 2020 acquisition of Shuton and Ipiranga by the Italian company Nadella. Similarly, the 2016 takeover of Bolueta Engineering by UK investors illustrates the exceptional nature of such transactions. At the time, the new owners described the deal as unusual, given the general absence of foreign acquisitions in the Basque industrial sector (Bolueta Engineering Group (2017)). Overall, only a small fraction of the district's end producers and suppliers are under foreign ownership.

Similarly, virtually all INMLs in the Basque metalworking machinery district are locally owned, and all are home-grown—none were established by foreign firms or entered the district from abroad. The sole exception is Lantek, which saw the entry of foreign capital following its acquisition by the German machine tool manufacturer Trumpf Gruppe in 2021.

Regarding the presence of large conglomerates in this district, the Mondragon Cooperative Corporation is particularly noteworthy. Although it is not a holding that expands through acquisitions or the incorporation of new firms, it represents a stable ownership structure within the district. Member companies of Mondragon—such as the INMLs Danobat, Fagor Arrasate, Fagor Automation, Loramendi, and Soraluce—are worker-owned cooperatives, which significantly reduces the likelihood of takeovers. Moreover, as several other firms in the Basque metalworking machinery district are also employee-owned, this cooperative model acts as a barrier to the entry of foreign ownership.

4.3.3 Trade between upstream and downstream segments within iDs

Castellón ceramics district Tile producers in Castellón rely heavily on local suppliers, including their respective INMLs. According to the most recent regional input-output tables, ceramic tile manufacturers in Castellón sourced 88% of their frits, glazing, and coloring materials from within the region (see Tab. 13 in Supplementary Material). To avoid overdependence on any single supplier—such as Esmalglass or Torrecid, which, for certain products, supply nearly all tile manufacturers—tile producers typically adopt a dual-sourcing strategy for frits, glazes, and colorants.

Ceramics machinery is supplied a lot less from within the region, as a significant share of their production equipment is imported from Italy. Approximately 35% of this equipment is procured locally (see Tab. 13 in Supplementary Material), with the remainder primarily sourced from manufacturers in Italy. In response to this external dependence, several Italian firms—such as Barbieri & Tarozzi, Coesia, LB, and SACMI—have established a local presence in Castellón to strengthen commercial ties with tile producers in the district. Some of these Italian suppliers hold a highly dominant position in their niche. For example, the group around Barbieri & Tarozzi (SITI) has installed machinery in all tile-producing companies in Castellón. As a result, the supply side exhibits oligopolistic traits, which encourage single or dual sourcing practices while making multiple sourcing strategies more difficult.

The supply of inkjet printers remains predominantly local. These machines are produced entirely in Castellón, with Kerajet and Cretaprint as exclusive suppliers, used by tile producers through single or dual sourcing.

Conversely, when considering intra-district trade from the suppliers' perspective, a different picture emerges. The frits, glazes, and colouring suppliers (including their INMLs) serve a geographically diverse client base, including tile manufacturers in countries such as Italy, China, India, Brazil, the United States, and Indonesia. As a result, their sales are only marginally dependent on demand from tile producers in Castellón.

By contrast, ceramics machinery producers based in Castellón exhibit a stronger reliance on local clients. Even the local subsidiaries of the Italian machine manufacturers that were mentioned before are largely dedicated to serving tile producers on the domestic (Castellonese and Spanish) market. The inkjet printing producers behave different from the rest of the ceramics machinery segment, as they do have a diversified, international, basis of clients.

From a sectoral perspective, the sales of frits, glazes, and colorants producers are strongly oriented towards the ceramic tile industry. The tile industry is also the primary market for the ceramics machinery producers, although some firms are applying their machining technologies to other sectors—such as grinding solutions for general construction or agriculture.

Basque metalworking machinery district Metalworking machinery manufacturers obtain most of their inputs locally. Half of the value they consume in specialized components and electronic, optical, and digital equipment comes from local sources

(see Tab. 14 in Supplementary Material). Approximately 30% is imported, while the remaining share is supplied by companies located elsewhere in Spain (ibid).

In the case of mechanization, engineering, and treatment of metal parts, two-thirds of the value is provided by suppliers based in the Basque Country, one-quarter is imported, and the remaining 10% comes from suppliers in other parts of Spain (see Tab. 14 in Supplementary Material).

The machinery-building INMLs in this industrial district appear to rely even more heavily on nearby suppliers, reporting that purchases from local sources account for between 60 and 90% of their total procurement value.

Specialized component suppliers export two-thirds of their output, indicating limited dependence on local sales to metalworking machinery manufacturers. In contrast, suppliers of electronic, optical, and digital equipment, as well as those involved in the mechanization, engineering, and treatment of metal parts, export significantly less—only about 40% of their sales go abroad. However, their value propositions are also relevant to a broader range of industrial users. As a result, they arguably serve a more sectorally diverse audience than the specialized component suppliers.

4.3.4 Characterization of INMLs-ID constellations

Interpreting the information from Sections 4-2 and 4-3-1 to 4-3-3 by means of the Markusen (1996) typology, leads to the summary shown in Tab. 5.

Altogether, the Basque metalworking machinery district continues to largely resemble the Marshallian industrial district. It is chiefly made up of SMEs, particularly on the supply side. The fact that the producers of finished goods are larger in size than the suppliers, while generally remaining medium-sized, also matches the Marshallian ID. Likewise, the number of producers of finished goods and certainly of suppliers in this ID remain numerous. Moreover, few M&As have taken place among businesses from the respective segments, and the inflow of foreign capital to take over (leading) companies has also been limited. This implies that local company ownership remains strong in this ID. Furthermore, the producers of finished goods act as the strategic leaders of the district, providing downstream propulsion to this ID. One, because they invest more in R&D, they file more patents and their innovations are technologically more path-setting than those of the suppliers in this district. Two, because they also have an overweight on the supply side in terms of internationalization. Internationalization is predominantly export-based, with very few companies counting with overseas production capacity. This is also in line with the Marshallian ID habit to operate entire value chains from the home base.

Manufacturers of finished goods also continue to rely strongly on local sourcing and can mostly chose between a variety of suppliers for inputs. However, this strong reliance on intra-district trade is not mimicked by the supply side, as local input providers to finished machine builders either export intensively or because their value propositions are suitable for a diversified clientele across different sectors. Hence, intra-district trade dependency is asymmetric for this ID. This is probably the one feature where the Basque metalworking machinery district deviates from textbook Marshallian ID characteristics.

Table 5 Schematic characterization of industrial districts analyzed in Castellón and the Basque Country. (Source: own elaboration)

	Producers of finished goods with a downstream position			Suppliers with an upstream position			Market structure	International business development	Technological development
	Typical size	Origin of ownership	Reliance on local suppliers for purchasing	Typical size	Origin of ownership	Reliance on local buyers for sales			
Castellón ceramics district	Medium-sized	Local ownership rules (also in the form of local holdings)	High for supplies of frits, glazes and colorants	Large-sized among suppliers of frits, glazes and colorants	50-50 local/foreign among suppliers of frits, etc. (surge of local and foreign conglomerates)	Moderate for most local suppliers of frits, etc. who export a fair share of their production and some even count with production abroad High for ceramics machinery suppliers operating from Castellón	Myriad-several Mainly single/dual sourcing	Upstream propulsion (suppliers of frits, glazing and colorants)	Upstream propulsion (suppliers of frits, etc.) External propulsion as regards ceramics machinery (Italy)
		Only a small share of tile producers is owned by foreign firms (some are run as conglomerates)	Moderate for ceramics machinery, which is mostly imported	Small-sized among machinery suppliers, although some belong to large (foreign) groups	Suppliers of ceramics machinery are mostly local-owned, complemented by Italian-owned suppliers				
Basque metal-working machinery district	Medium-sized	Local ownership rules (including in the form of cooperatives)	High for mechanization, engineering and treatment of metal parts, substantial for specialty components and equipment	Small-sized	Local ownership rules	Moderate, as many local suppliers export a significant share of their production or can diversify their sales across various sectors	Several-Myriad Substantial multiple sourcing possibilities	Downstream propulsion (producers of finished goods)	Downstream propulsion (producers of finished goods)
		Foreign ownership is exceptional			Foreign ownership is exceptional				

Instead, the Castellón ceramics district incorporates many characteristics that represent an evolution from the textbook Marshallian industrial district type. To begin with, in terms of average company size, the district includes a significant share of large firms, particularly on the supply side among manufacturers of frits, glazes, and colouring products. On average, these upstream suppliers are even larger than the producers of finished goods. Regarding market structure, the district presents an inverse pattern to what is typically observed in Marshallian industrial districts: there are much more producers of finished goods than critical input providers. This is true for suppliers of frits, glazes, and colouring materials (notably including INMLs), and also for producers of inkjet printing technologies. As a result, the supply side exhibits certain oligopolistic traits, which complicates multi-sourcing strategies for some critical inputs.

In terms of ownership, the district now includes a significant presence of foreign-owned companies, especially in the upstream segment of frits, glazes, and colouring products. Both local and foreign conglomerates have also emerged among tile manufacturers and the suppliers of frits, glazes and colorants. Meanwhile, although most ceramic machinery firms located in Castellón are of local origin, the leading players in this segment are foreign-owned—predominantly Italian.

Producers of finished goods still rely primarily on local suppliers for frits, glazes, and colouring materials. However, they depend largely on foreign suppliers for ceramic machinery, which contrasts with the traditional Marshallian model in which the entire value chain is district-internal. While the ceramic machinery firms with production facilities in Castellón predominantly serve local downstream firms, the frits, glazes, and colouring producers are significantly more export-oriented, with only a minority of their production destined for local sales.

When evaluating which segment(s) most strongly drive the development of internationalization and technological advancement within this industrial district, a notable departure from the traditional Marshallian ID pattern also emerges. Specifically, the upstream segment of frits, glazes, and colouring products has given rise to multinational firms with substantial production capacity abroad. In contrast, the downstream tile producers are primarily focused on exporting finished products, resulting in greater international dynamism originating from the upstream segment.

In terms of technological development, both the frits, glazes, and colouring suppliers, as well as the ceramic machinery manufacturers, surpass tile producers in patent activity. Moreover, these supplier segments have introduced innovations that have significantly influenced not only the district's technological trajectory but also that of the broader ceramics industry.

Finally, the strong presence of foreign actors—particularly Italian firms—in the ceramics machinery sector introduces a considerable degree of external technological influence. In Fig. 6, we provide a stylized representation of how both IDs can be pictured.

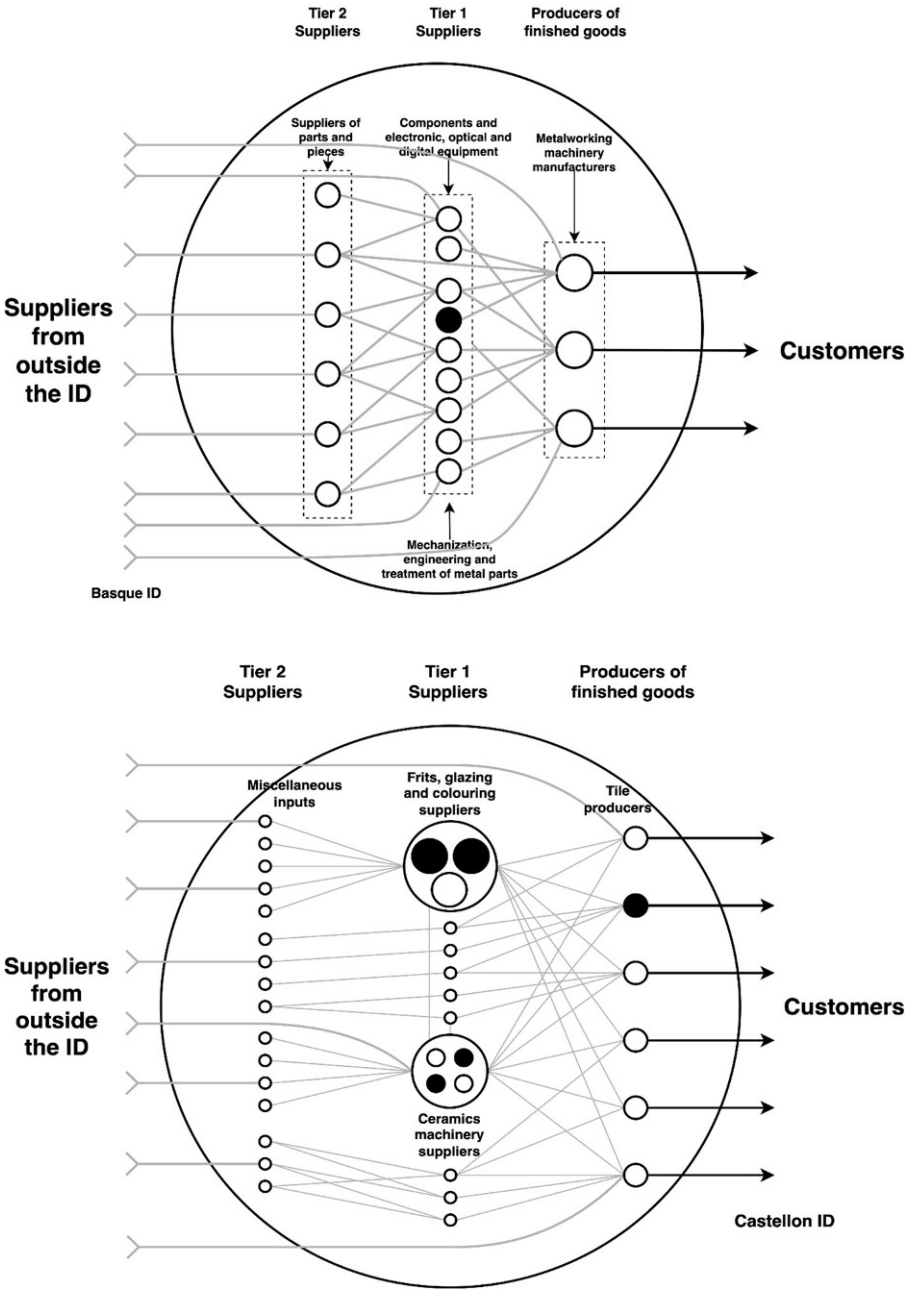

Fig. 6 "Marshallian metalworking machinery district from the Basque Country" and "foreign-participated ceramics district with oligopolistic traits on the supply side from Castellón". Black dots symbolize foreign-participated firms. Diameters of nodes symbolize average size of upstream and downstream firms. (Source: own elaboration.)

5 Discussion and implications

5.1 INMLs as part of iDs

With regard to our first research question, our findings clearly demonstrate that INMLs can and do form part of industrial districts. In line with recent studies by Benz et al. (2021), Schenkenhofer et al. (2024), and Lehmann et al. (2025), our research provides evidence that analyzing these types of firms within their territorial and industrial contexts is both meaningful and necessary. Our case studies strongly support the view that a meso-economic perspective is appropriate for such investigations.

Concerning the genesis of INMLs and their potential connection to the IDs where we find them, our findings resonate with the observations of Krugman (1991) and Porter (1990), who argue that internationally competitive clusters often host multiple global leaders in the same core industry. In this respect, our work aligns with Lehmann et al. (2025), who identify geographical concentrations of niche market leaders across Germany. It also supports the insights of Audretsch et al. (2021), who propose that hidden champions emerge from localized industrial and/or technological specialization patterns, underscoring the impact of history on the (regional) development of international niche market leaders and industrial districts (Ciccarelli and Schmidt 2022). Furthermore, it resonates with Asheim (2024) argument that INMLs and IDs represent the micro- and meso-economic dimensions of the same phenomenon: technologically sophisticated firms focused on niche markets.

Finally, although some scholars question the relevance of local customers for INMLs (e.g., Simon 2009; Rammer and Spielkamp 2015; Schenkenhofer 2022), the Castellón ceramics case illustrates that INMLs can achieve global niche dominance after lead users in their immediate vicinity act as springboards for their growth. This finding reinforces Porter (1990) foundational ideas on how clusters (can) come about and underscores the importance of examining the role of local clients in firm growth (Behr et al. 2023).

5.2 INMLs and propulsion of iDs

Regarding the second research question; can the predominant presence of INMLs in either the downstream or upstream end of an ID be indicative of which segment propulses it from a technological and international business perspective?, we can also answer affirmative. Both cases analyzed revealed how INMLs concentrate in a specific (downstream or upstream) segment, and in both cases this was were most international and technological dynamism could be encountered. Several implications can be derived from this establishment. One, the relationship between INMLs and IDs can be symbiotic. Not only can INMLs reap benefit from agglomeration advantages rendered by spatial-economic concentrations or agglomeration clusters (Porter 1990). But also, they can contribute to the international business and technological vibrancy of their industrial environments (Benz et al. 2021). Two, as the Castellón ceramics district reveals superior internationalization and patenting prowess among the downstream suppliers of frits, glazing and colouring products,

this relativizes the default assumption that ID leadership and its strategic direction is a downstream end affair (Albino et al. 1999; Carbonara et al. 2002; Munari et al. 2012; Bacchiocchi et al. 2014). Contrary to the common view that ID leadership resides in downstream producers, we show that upstream segments—thanks to superior innovation performance and ditto international orientation—can also serve as engines of ID development.

To explain why INMLs—including those from upstream segments of industrial districts—may serve as drivers of IDs' technological agenda and international orientation, we can point to their comparatively strong patenting performance relative to their peers (Johann et al. 2021; Lampe et al. 2024). Even if they may not always spend more resources on R&D—as per the frits, glazing and colouring producers from Castellón, their innovation output tends to be higher (Rammer and Spielkamp 2019). Their overweight on others in terms of internationalization can be understood through Zucchella and Palamara (2006) finding that niche firms show a higher propensity to internationalize.

Additionally, a sector-specific reason as to why we find in the Castellón ceramics industry that the supply side drives internationalization and technological development can be derived from Scur and Garcia (2019). They reason that the maturing of end-user markets can lead ceramic tile producers to depend increasingly on frits, glazing and colouring input providers as differentiation become of vital importance. More in general, the propulsion of the Castellón district by upstream players or segments resonates with Becattini (2002, 2004) mentioning of the possibility that key upstream suppliers (who provide advanced inputs, machinery, or specialized services) lead a district's innovation and modernization trajectory.

5.3 Classifying iDs that host iNMLs from a markusen typology perspective

In response to the third research question, whether IDs that host INMLs can be classified within the existing typology, or whether Markusen's framework requires a broadening or refinement of its taxonomic categories to accommodate such cases, the answer is twofold. On the one hand, a yes and a no, as the Basque case chiefly complies with the seminal Marshallian ID (fifth cell from the bottom in the third column of Tab. 6), while the Castellón ceramics case does less so. Concretely, the Castellón ceramics district holds somewhat the middle between an "Industrial district with oligopolistic traits on the supply side" and a "Foreign-participated industrial district with oligopolistic traits on the supply side" (bottom cell in the third and fourth columns of Tab. 6). On the other hand, the answer is that a refinement of the Markusen typology suffices and that no further broadening and inclusion of additional archetypes is needed. I.e., if we focus on market structure and ownership characteristics of firms in IDs, we can refine the Markusen typology in the following manner:

The Castellón case reveals that the INMLs it hosts have played a central role in the transformations that have shaped the district's current configuration. Their strong market position makes them indispensable for the demand side's access to certain key inputs, endowing the supply side with oligopolistic characteristics. These firms have attracted foreign capital, established themselves from abroad, and/or partici-

Table 6 Industrial districts typology based on market structure and ownership characteristics. (Source: own elaboration.)

Market structure		Main actors' ownership characteristics		
		Private		Public
Number of buyers	Number of suppliers	Local	Foreign	
Single/few	Single/few	Hub-and-spoke district	Satellite industrial platfom	State-anchored district
Several	Many	Marshallian industrial district	Foreign-participated Marshallian industrial district	State-participated Marshallian industrial district
Single/few	Many	Industrial district with monopsonistic traits on the demand side	Foreign-participated industrial district with monopsonistic traits on the demand side	State-participated industrial district with monopsonistic traits on the demand side
Many	Single/few	Industrial district with monopolistic traits on the supply side	Foreign-participated industrial district with monopolistic traits on the supply side	State-participated industrial district with monopolistic traits on the supply side
Several	Many	Industrial district with oligopolistic traits on the demand side	Foreign-participated industrial district with oligopolistic traits on the demand side	State-participated industrial district with oligopolistic traits on the demand side
Many	Several	Industrial district with oligopolistic traits on the supply side	Foreign-participated industrial district with oligopolistic traits on the supply side	State-participated industrial district with oligopolistic traits on the supply side

pated in local consolidation processes through mergers and acquisitions. Moreover, they are among the industrial district members that have grown beyond SME status. As part of the supply side, their disproportionate size compared to demand-side actors reinforces the perception of upstream-driven dynamics in the district, supported by their superior performance in patenting and internationalization. Interestingly, the consolidation of firms—through weeding out processes and takeovers—as well as a growing presence of foreign-owned companies, are among the features that Giuliani and Rabellotti (2017) associate with industrial districts becoming more outward-oriented. This is certainly reflected in the formation of conglomerates around firms like Esmalglass, Torrecid, or other suppliers, which have established production plants in several of the world's leading tile-producing countries.

5.4 Implications for policy makers

As Marshallian industrial districts can evolve in diverse ways, so too should the policy measures designed to support them. If a district maintains strong intra-district trade and buyer-supplier relationships, and if the producers of finished goods provide strategic leadership, it may be most effective to identify missing inputs or providers. In such cases, targeted foreign direct investment incentives could attract these actors to the district, thereby enhancing the competitiveness of its finished products.

Conversely, if the segment with the highest systemic relevance in the district lies upstream (on the supply side), and the producers of finished goods are not multi-localized but depend heavily on exports, then policy support should take a different approach. This may involve helping upstream suppliers find external buyers for their products, as a means of driving internationalization across a broader range of district firms. In parallel, providing technology intelligence services can help these suppliers stay abreast of global technological developments—strengthening their position in international markets and, in turn, benefiting their downstream clients at home. Also, encouraging local support structures—such as technology or training centers—to pay more attention to firms occupying pivotal upstream positions in local districts aligns well with this approach.

The presence of high or asymmetric dependence among members of an industrial district—where some actors rely heavily on others without reciprocal dependence—can be a concern for policy makers and may require mitigation measures.

Upstream segments in industrial districts—even if they host international niche market leaders—tend to receive less visibility than their downstream counterparts. Yet when these firms are critical to the district's competitiveness, they warrant active policy support, including employer branding initiatives. Their traditionally weak image in the labour market can hinder talent attraction, so raising their public profile serves a shared interest in sustaining the district's long-term competitiveness.

6 Limitations and suggestions for future research

This paper presents a challenging research endeavor, which, like any, is not without its limitations. Its results are contingent upon the data available across the cases

(INMLs and IDs) and regions examined and the comparability of the available data. This certainly puts a mortgage on presenting IDs in a uniform way, comparing them on equal grounds and when drawing up comparison across places. In a similar vein, analyzing composite objects such as industrial districts from a micro (INMLs) and meso-economic (regional or sectoral data analysis) perspective can make it difficult to align data.

In continuation of our analysis of industrial districts hosting multiple INMLs, we view the following research directions as particularly promising: One, investigate whether the phenomenon of INML-ID constellations also occurs in Italian regions. This could be done by integrating the data behind the hidden champions map developed by Schenkenhofer et al. (2024) with the ISTAT inventory of industrial districts in Italy.

Two, building on our observations of the Castellón ceramics district and on Scur and Garcia (2019) remark that maturing end-markets may increase downstream producers' reliance on suppliers for differentiation and competitiveness, explore whether similar dynamics are present in other districts with a focus on mature industries (e.g., home appliances, white goods, agricultural equipment). Specifically, examine whether upstream propulsion is a common pattern in such contexts. Additionally, consider whether regional authorities can implement supportive measures to guide or facilitate such 'leadership transitions.'

Finally, we believe that a more in-depth analysis of industrial districts' market structures—including the relative sizes of buyers and suppliers, and dependencies between them—and how these characteristics shape leadership and power relations within IDs would be highly relevant. Particularly in regions like Castellón, where a large share of employment depends on a specific industrial district hosting several international niche market leaders, studying the dynamics of these leaders within the industrial district setting appears especially worthwhile.

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