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Regional development and global production networks: the case of the semiconductor industry in Wales

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ABSTRACT

This article explores the interface between global production networks and regional economic development. The case study focuses on the semiconductor industry in Wales where multinational enterprises are, with regional institutions, developing deeper forms of regional embeddedness. Although these firms boost the Welsh and UK economies through wage, export and knowledge effects, their scope to support more fundamental regional development is constrained by their internationally focused trade patterns. The case raises issues as to how the semiconductor industry might, in seeking to advance regional development, improve domestic up- and downstream supply chain integration, whilst not undermining its international cooperation and trade.

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1. Introduction

There has been a discussive shift in policy debates and academic thinking related to global supply chains and regional economic development (Martin, 2021; Pike et al., 2017). Factors such as heightened global economic disruption, geopolitical tensions and political uncertainty and, more recently, tariffs have challenged previously received thinking (Flynn et al., 2021; Yeung, 2024). One policy manifestation has been the introduction of initiatives designed to 'reshore' manufacturing (Lund & Steen, 2020; Sodhi & Tang, 2021). Although much of this policy agenda has been driven by concerns to improve economic and technological security (Capri, 2025), there has been a growing interest in securing regional development dividends that may arise from supply chain relocalisation strategies. Thus far, however, reshoring policy initiatives have not sufficiently addressed the challenges of successfully integrating newly reshored industries with existing regional and national enterprises (Bornert & Musolino, 2024).

From the perspective of regional development theory, in particular concepts couched within frameworks related to global production networks (GPNs) and evolutionary economic geography (EEG) (Lee, 2024; Rodríguez-Pose, 2021), scholars have suggested that the changing global supply chain landscape may lead to a 'resurgence of the regions' (Yeung, 2024). The semiconductor industry offers a useful case study to explore current thinking at the intersection of supply chain management and regional development. The industry has developed a global product chain which is a critical technology and has a high value-added contribution to regional economies. As in other industries, however, domestic product supply chain integration aimed at securing regional economic gain remains an underdeveloped policy dynamic (Semiconductor Industry Association (SIA), 2021). Through a case study of the developing semiconductor industry centred on South East Wales, this article seeks to understand the various challenges in realising these benefits.

The South East Wales semiconductor industry is seeking to build stronger regional coupling. As the case study shows, multinational enterprises (MNEs) associated with the semiconductor industry are developing deeper forms of regional embeddedness. These include bringing headquarters functions, developing

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technological solutions locally, forging closer industry ties to regional institutions and training providers, and significant university engagement. However, although the semiconductor companies boost the Welsh and UK economies, their scope to support more fundamental regional development processes may be constrained by their internationally focused trade patterns. Between them, these MNEs occupy elements of the global semiconductor product chain, but it is found that they are not integrated in a spatially located seamless chain *within* Wales or the UK. The case raises issues as to how the UK semiconductor industry might, in seeking to advance regional development, improve domestic up- and downstream supply chain integration, while not damaging the international cooperation and trade inherent in the industry's business model.

Given the above, the core research questions addressed are as follows. First, to what extent does Wales's post-industrial legacy influence its ability to integrate with semiconductor GPNs? Second, is the regional economic ecosystem in Wales robust enough to develop embedded relationships with MNEs? Third, can Wales leverage GPN participation to achieve wider structural transformation in its regional economy? In addressing these questions, this article considers the extent to which the Welsh case illuminates the broader challenges of securing greater regional economic gain through supply chains within a strategically important industry. To address these questions, the following section explores the literature concerning EEG and GPNs in the context of emerging issues in the global semiconductor industry and more domestically in the UK and Wales. The article then presents the methods and the case material. Finally, a discussion examines the implications of the case in relation to the research questions.

2. Evolutionary economic geography and GPNs

This section considers how lagging regions might advance 'emergent' integration with GPNs in high-tech industries, such as semiconductors, in the furtherance of regional development agendas. Globally leading firms can contribute to economic development in regions with historically limited GPN integration (Fuller & Phelps, 2018). This is particularly significant in the context of the semiconductor industry given its long-established globalised value chains, which have been critical to its significant growth and near continual innovation (Huggins et al., 2023; Yeung, 2022b). Typically, however, lagging regions tend to occupy elements of such value chains whereby there is scope for only limited regional value capture (Barzotto et al., 2019). How then can lagging regions more fully harness the power of high-tech GPNs?

Two of the most significant and impactful theories that have been deployed in the context of regional economic development in recent years are EEG and GPNs. The discourses on EEG and GPN provide important insights into extra-regional linkages, production network dynamics and the endogenous factors contributing to regional economic diversification strategies (Yeung, 2021). Of particular interest here is Global Production Network Theory 2.0 (GPN 2.0), which extends the foundational work of GPN 1.0 around firm networks and territorial institutions involved in globalised economic activity by placing greater emphasis on external networks and highlighting the dynamic agency of firms (Coe & Yeung, 2019). By contrast, EEG emphasises internal, historical and institutional dimensions that influence patterns of regional diversification (Boschma & Martin, 2010). As this review indicates, whilst the two theoretical perspectives share commonalities and provide valuable insights for regional development policy landscapes, they also display clear distinctions in their respective emphasis on global network dynamics and local evolutionary processes. Such contrasting perspectives are not necessarily mutually exclusive.

While the EEG and GPN 2.0 literatures have historically tended to develop independently, recent scholarship has sought to integrate the two perspectives (Boschma, 2024; Lee, 2024). These integrated insights have explored global distribution and networks underpinning international production and regional development (Poon, 2024; Rodríguez-Pose, 2021; Yeung, 2021). The following sections seek to adopt this relatively recent integrative understanding of some of the core concepts drawn from EEG and GPN 2.0 theories – including strategic coupling, path dependence, embeddedness, value capture and path creation – to provide further important combined insights into regional development agendas generally and more specifically the semiconductor industry (Boschma, 2024). These core EEG and GPN 2.0 concepts help inform understandings of semiconductor GPN development in Wales and provide an analytical framework to address the core research questions.

2.1. Path dependence versus path creation: breaking through regional lock-in in high-tech development

To understand how lagging regions may integrate into semiconductor or other high-tech value chains, it is essential to consider whether progression builds upon existing regional competencies or necessitates significant departures from established developmental paths. EEG understands this dichotomy as 'path dependence' versus 'path creation' (Chu & Hassink, 2023; Isaksen & Trippl, 2017). This nexus is particularly significant for lagging regions (such as Wales in this case) where a central challenge can be the creation of new development trajectories that break from historical capabilities to maximise the spillover gains from new high-tech investments.

In the context of the semiconductor industry, it has been argued that Europe, the US, Japan and South Korea have established monopolistic trade practices by shaping trade agreements and forming strategic corporate alliances (Ren et al., 2023, p. 1155). These countries have promoted the industrial division of labour and global distribution of the semiconductor value chain, controlling this through trade agreements and technological monopolies and effectively blocking the path development of excluded economies (Ren et al., 2023). This may hold back GPN integration of smaller scale semiconductor industries in advanced economies such as the UK (Sharma, 2023). A GPN is essentially a system of interconnected functions, operations, and transactions to produce and distribute a particular product or service, involving firm and non-firm actors. In this context an observed weakness of the UK semiconductor industry is 'a mismatch between the output from UK FABs … and the requirements of UK manufacturing or technology firms' (BEIS Committee, 2022, pp. 17–18).

Given these limitations, the EEG literature suggests that the ability of a region to develop more complex value chains depends on their degree of relatedness to existing value chains (Boschma, 2024). Regions with limited value chain capability are also more likely, it is suggested, to access knowledge and technology externally, often facilitated by MNEs (Arora & Hartley, 2020). EEG understandings are therefore based on endogenous and evolutionary perspectives, highlighting 'path dependence', and the gradual development of regional capabilities (MacKinnon et al., 2019). This theory is not without critique, however, with some scholars identifying that certain previously lagging regions have successfully achieved rapid 'path creation' possibilities (Rosés & Wolf, 2018). However, EEG remains a core theoretical foundation for understanding regional development.

One particularly significant conceptual explanation of regional development emerges from the GPN 2.0 literature. Building upon the earlier GPN 1.0 model, GPN 2.0 provides dynamic perspectives on how regions participate in, and are influenced by, production networks (Yeung, 2022b). 'Strategic coupling', a concept central to GPN 2.0 theory, suggests that development strategies are best pursued by aligning regional assets and institutions with the needs of global lead firms (Fuller & Phelps, 2018). For Fuller and Phelps (2018), such alignment influences the nature and degree of regional coupling with GPNs, which varies between strong forms of coupling, exhibited by highly developed regional economies, and regions characterised by cost-focused foreign investment susceptible to disinvestment. This perspective is particularly salient to Wales with evolving semiconductor MNEs that increasingly appear to be spatially rooted, which contrasts with more typically experienced branch-plant-style inward investments (Fuller, 2023).

2.2. Embeddedness: building local capabilities while connecting globally

Lagging regions are typically more dependent on MNEs for technology transfer and the enhancement of their value chain capabilities (Martinez-Solano & Phelps, 2003). This presents a significant challenge for less developed regions: how to build deeper relationships with MNEs, particularly those that have already established themselves within other regional economies, to leverage stronger value chain integration whilst building local capabilities (Crescenzi & Harman, 2023). For lagging regions to avoid 'enclave development' in high-tech GPNs, such as semiconductors, it is necessary to understand how external connections can build on local capabilities.

The GPN 2.0 understanding of the concept of 'embeddedness' addresses the depth of integration between global networks and local economies (Yeung, 2016). This concept relates to how firms and actors root and

integrate themselves within regional institutional, social, and economic contexts. In this space, the 'firm–territory nexus', which refers to the reciprocal relationships between firms and the regions they operate within, highlights how firms leverage local assets (infrastructure, institutions, and labour pools) while also shaping regional development. GPNs are thus, from this perspective, linked to regional economies through coordinated strategies, whilst aligning local capabilities with global demands to foster mutual benefit (Torre, 2025).

Both the EEG and GPN 2.0 literature recognises the role of national and local institutions in mediating regional development outcomes (Hassink et al., 2019). Understanding the role of local and regional governance, institutional frameworks, and policy landscapes in shaping outcomes is, therefore, increasingly relevant. Such dynamics are central to considerations of how lagging regions might achieve deeper embeddedness with MNEs (Balland & Boschma, 2021), such as those within the semiconductor industry in Wales. Given this, building local institutions that engage with regional universities and facilitate knowledge spillovers and capability development are potentially important precursors to enhancing value capture from regional GPN participation, and avoiding the 'enclave trap' (Lehmann et al., 2022).

2.3. Value capture trajectories: positioning lagging regions in high-tech value chains

Concerning the range of geopolitical, economic and environmental factors currently impacting on globally constructed semiconductor product chains (Grimes & Du, 2022; Moktadir & Ren, 2024), two major issues are emerging. First, given the vulnerabilities of global semiconductor production, how might countries best reduce their exposure to the growing risks associated with such a model? Second, how might regions with existing semiconductor industries capture a greater share of up- and downstream supply chains (Xiong et al., 2025). Policy responses have tended to be far more focused on the first issue. This centres on the extent to which domestic economies can maximise the benefits derived from reshoring overseas activity (Munday et al., 2024b). To fully appreciate how lagging regions can economically benefit from participation within semiconductor GPNs, it is necessary to consider mechanisms of value capture. In particular, it is important to note that regional positioning within a GPN is likely to strongly impact upon economic outcomes (Ma et al., 2019).

For Yeung and Coe (2015) 'value capture' explains the role of mutual dependencies between producers and consumers in intermediate markets, supported by spatial, organisational and cultural proximity, in driving innovation and responsiveness, and close interfirm ties shaping tacit transfer of knowledge and advanced process technologies. From this standpoint, firms navigate GPNs using a mix of control (such as vertical integration and intellectual property rights) and partnership (such as alliances and outsourcing) (Lang et al., 2025). Particularly important for lagging regions is the fact that outsourcing is no longer just cost-driven but has become a strategic tool for greater flexibility in high-tech sectors (Yeung & Coe, 2015). In Yeung's (2022a) 'network' understanding of the economic–geographical process of value transformation, production networks bring firms and non-firm actors together and create economic value. Understanding these dynamics is therefore critical for regional value capture strategies.

The GPN literature often refers to the 'upgrading' of regional industries or industrial functions, with some functions effectively ranked higher than others (Boschma, 2024). In a development of Shih's (1996) product value chain model, Capello and Dellisanti (2024) apply a 'smile curve' type approach to industrial functions at an aggregate regional level to establish a categorisation of regional types based on predominant industrial characteristics. These include headquarter regions, factory regions and primary resource regions. Each of these regional types engage differently with GPNs based on existing regional resources and exhibit different growth trajectories. Alongside this approach, there has been a relatively recent reorientation of the governance of GPNs toward state-led, national security concerned and regulated systems (Lang et al., 2025). This has contributed to a growing interest in 'reshoring' and 'friend-shoring' (Capri, 2025). For firms, despite such heightened geopolitical contexts, reshoring decisions continue to largely hinge on cost, risk, and technology factors, but also reflect regional assets and policy measures (Lund & Steen, 2020; Yeung, 2022a). Thus, regional development is not only shaped by global forces, but also by agency at the local level.

2.4. Institutional mediation and the role of governance

Regional, national and industrial contexts are significant factors when considering the intersection of supply chain management and public policy and regulation (Fugate et al., 2019). Although growing trade and geopolitical tensions are increasingly impacting on both supply chain management and regional development (da Ponte et al., 2022), regions retain a degree of influence over their own economic outcomes and can set their own priorities. Such objectives are likely to require institutional mediation processes and while regional governance may act as an enabler of strategic coupling and policy frameworks, it does not exist in isolation from broader, national, and supranational institutions and governance (Lang et al., 2025). Various national strategies have emerged relating to the semiconductor industry (e.g. Department for Culture, Media and Sport (DCMS), 2023; European Commission, 2023). However, policy focus has tended to take a macro approach addressing entire product chains rather than focusing on specific segments of relevance to particular regions or nations.

Regional factors can have both positive and negative impacts on local semiconductor development, ranging from beneficial technology transfer and market access to risks of dependency and competitive displacement (Lang et al., 2025; Xiong et al., 2025). In the case of the UK, the National Semiconductor Strategy (DCMS, 2023) identified three primary objectives: to mitigate supply chain disruption; to protect national security; and to grow the domestic semiconductor sector. However, the strategy failed to address how far the UK's domestic manufacturing capacity would need to expand to meet these objectives, especially in relation to growing the domestic economy (Lang et al., 2025; Munday et al., 2024b).

2.5. Analytical framework: integrating concepts for understanding semiconductor GPN development in lagging regions.

This review has considered both EEG and GPN 2.0 theories and concepts relevant to high-tech regional development in lagging region contexts. The core concepts outlined here – strategic coupling, path dependence, embeddedness, value capture and path creation – provide important insights. These concepts work together to help describe regional development through semiconductor GPN building. The two underlying theories offer differing perspectives, but each make important contributions (Poon, 2024; Rodríguez-Pose, 2021; Yeung, 2021). One area where both EEG and GPN 2.0 frameworks appear to require further work is to better understand the role of regional institutions and non-firm actors. The empirical evidence presented in the case study to follow, as well as addressing the core research questions of this paper, provides further evidence regarding these dynamics.

Figure 1 illustrates how the core EEG and GPN 2.0 concepts can address a subset of questions within the context of the case study. This integrated approach will help guide the empirical analysis in the case study. It

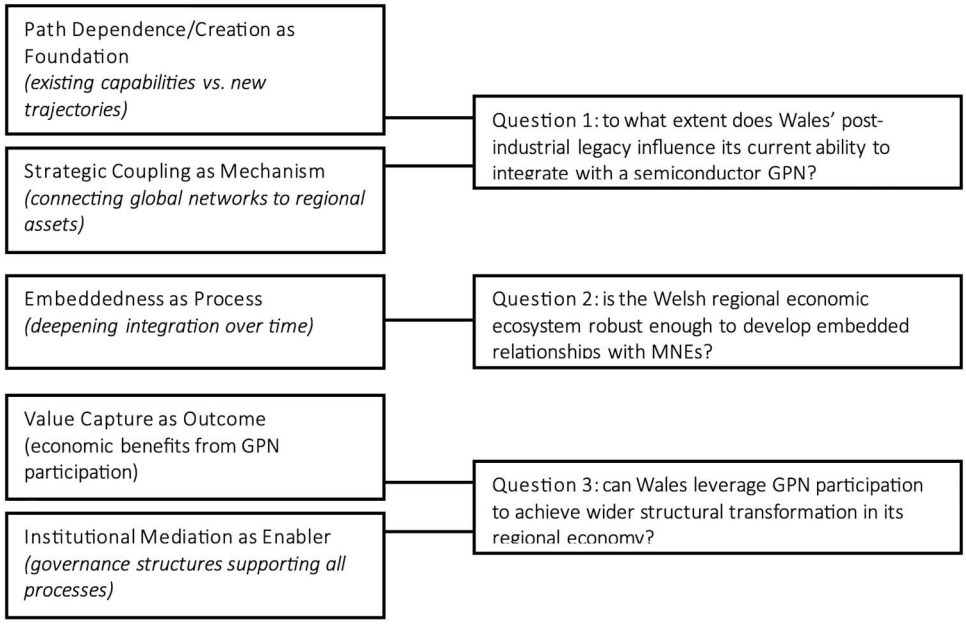

Figure 1. Concepts informing understandings of semiconductor global production network (GPN) development in Wales.

also provides a useful analytical framework for understanding Wales's semiconductor industrial development journey and potential future trajectories, both within the semiconductor industry and its wider economy. These are, of course, questions that can be asked in other regions at similar stages of industrial development and which are restructuring in a bid to grow nascent high-tech industries.

3. Methodology and context

3.1. Methods

The analysis was informed by research undertaken as part of a UK government-funded project examining the evolution of the semiconductor industry in South East Wales. This project, entitled CSconnected, and funded by the UK Research & Innovation's (UKRI) Strength in Places Fund (SIPF), was designed to build on existing regional strengths in advanced semiconductor materials and manufacturing. One critical element of CSconnected has been to strengthen local supply chains. Part of the CSconnected research consisted of an annual survey of the firms and publicly funded institutions that comprise the semiconductor industry in South East Wales. These were undertaken during September and October from 2020 to 2024. During later rounds information was also collected on employment supported at Cardiff University (Institute for Compound Semiconductors) and Swansea University (Centre for Integrated Semiconductor Materials).

These annual surveys collect information in respect of business activity, employment, earnings, capital and operational spending. In terms of business expenditure, the surveys gained information on key spend categories and geographical spending direction. Part of the emphasis here was to identify the nature of local and UK supply chains to the semiconductor cluster, and to understand the direction of final product sales. The expenditure data also enabled an analysis of regional spending multiplier impacts using the framework of the input–output tables for Wales (Jones et al., 2022). Survey data were complemented, for analytical purposes, with data from company accounts. In addition, information on industrial activity was gained from members of the research team attending regular meetings of the CSconnected chief technical officers group, which consisted of the collaborating manufacturing firms and organisations that were part of the initiative.

Case information was also developed from a series of interviews with key informants from the regional semiconductor industry. In total, 22 interviews (over a four-year period from April 2021 to May 2025) were undertaken through a mixture of in-person and online sessions. Of these, six interviews were undertaken with representatives of regional universities, research centres, and innovation centres; four with cluster organisations and industry associations; and 12 with semiconductor industry companies, including regional supply chain firms. Although these interviewees did not include policy officials, where appropriate policymaker perspectives were inferred from a project which supported an evaluation of an investment by the Cardiff City Deal (Cardiff Capital Region – CCR) in the local semiconductor industry (CCR, 2021). Interviewees were identified through the research teams' existing knowledge of the regional semiconductor industry and regional policy community, supplemented by an online search. Semi-structured interview techniques were utilised to provide a comparatively 'loose script', rather than asking participants to respond to predefined factors (Johansson, 2004). This approach gave respondents the space to outline their perspectives on the economic conditions of the subregion, as well as the evolution of the industry, the place of the business in value chains, obstacles to business development and future growth potential.

A thematic analysis involving a two-stage process was subsequently undertaken. The first stage coded the notes taken from each interview to the conceptual framework presented in Figure 1. The second stage undertook an analysis of the data under each theme to identify the main factors underpinning each of them (Fereday & Muir-Cochrane, 2006). As such, theoretical constructs were defined according to the extant EEG and GPN literature, providing a theoretical justification for the coding frame (Eisenhardt, 1989), and the analysis in the case study draws on the process of 'systematic combining' (Dubois & Gadde, 2002) whereby the theoretical is confronted with the empirical to juxtapose actual events with theoretical explanations. A further strand of data collection stems from a longer process of project, evaluation and study-based observation by the research team associated with this paper over a period of more than 25 years. Although this process of observation is a more informal data collection method, it provides useful

contextual background. The material stemming from the interviews, surveys, and observation, was 'fact checked' by reviewing policy or 'grey' literature to ensure the accuracy of the case study.

3.2. Context and case selection: the South East Wales region

Before proceeding to the findings, it is important to briefly consider the region surrounding the evolving industry. Wales has a longstanding and deeply ingrained experience of economic underperformance and low gross value-added (GVA) per capita levels when compared with the UK average (Henley, 2024). Post-industrial Wales has seen the replacement of traditional manufacturing jobs with low value service jobs. Consequently, Wales experiences relatively poor labour productivity (GVA per job).

Despite some notable strengths in developing its service sector, such as the finance sector in Cardiff, some have suggested that the business culture in Wales has tended to demonstrate poor innovative capacity and limited entrepreneurship (Huggins & Thompson, 2015). In this respect the formation of the CCR (made up of 10 South East Wales local authorities and funded by a City Deal involving finance from the UK and Welsh governments) has renewed the collaborative agenda to support regional growth through investment, upskilling and connectivity. CCR is seeking to achieve a diversity in its subregional business base including efforts to develop a compound semiconductor cluster (CCR, 2021).

As a peripheral, post-industrial region with a notable and expanding semiconductor industry – distinct from its prevailing regional economic trends – South East Wales provides an opportunity to examine the value of both EEG and GPN frameworks. Moreover, there has been limited research into Wales's semiconductor industry. The case study not only addresses the role of industrial path development, but also examines the significant and high value-added integration of the South East Wales industry within global semiconductor production networks. This appears to diverge from the general trend described, for example, by Barzotto et al. (2019) of lagging regions occupying only low value elements of value chains.

4. The South East Wales semiconductor industry

This section examines the evolution and current state of the South East Wales semiconductor industry using the integrated EEG and GPN 2.0 theoretical framework presented above. The analysis addresses the subset of three research questions concerning path development and strategic coupling, embeddedness, and value capture through institutional mediation.

4.1. Structure of the industry

The South East Wales semiconductor industry is a cluster of firms, research institutions and public-sector bodies that has undergone significant recent transformation. At its core, the integration of cluster activity and external positioning is coordinated through the CSconnected initiative, a not-for-profit trade organisation, with funding from the UK government via the UKRI's SIPF. CSconnected represents the Welsh organisations directly engaged in research, development, innovation and manufacturing of semiconductor technologies, and provides the central organising platform linking industrial actors, universities and intermediary institutions.

The regional industry's membership encompasses leading private sector manufacturers, specialist design and research and development (R&D) firms, universities, and national innovation agencies. The principal industrial players are IQE, KLA (owner of SPTS Technologies), Microchip Technology and Vishay International, all of which operate substantial manufacturing facilities. These are complemented by smaller, high-value niche firms such as Kubos Semiconductors, Microlink Devices and Ffotoneg. On the research and innovation side, Cardiff University's Institute for Compound Semiconductors and Swansea University's Centre for Integrative Semiconductor Materials provide significant translational research capabilities, while the Compound Semiconductor Applications (CSA) Catapult serves as a UK-wide centre of expertise linking the research base to commercial applications. The Compound Semiconductor Centre (CSC), originally a joint venture between Cardiff University and IQE, supports the translation of research into manufacturable technologies. Public-sector partners include the CCR City Deal and the Welsh Government, both of which play a strategic role in funding and coordination.

There was strong growth in the cluster between 2017 and 2024, whereby the number of core organisations increased from five to 13, reflecting a combination of inward investment, spin-outs and targeted recruitment of strategically aligned firms. New entrants include Cadence Design Systems (establishing a joint venture with the CSA Catapult in 2025), Siemens (with an innovation centre inside the CSA Catapult facility), Kubos Semiconductors and Ffotoneg, all of which have enhanced the cluster's technological scope and international connections.

The expansion of the regional semiconductor industry has been supported by a substantial programme of public and private investment. City Deal has invested £38.4 million to the IQE Foundry, £3.2 million to CSconnected and £3.3 million to cluster development and growth. The UK government has further invested £25.4 million for CSconnected, £15.1 million in matched in-kind or cash contributions, £40 million to support CSA Catapult and £3.3 million Shared Prosperity (a UK-level funding allocated to local level initiatives) funding for cluster development (SQW, 2024). Beyond direct capital injections, CCR and its partners have implemented a range of interventions aimed at embedding and sustaining growth. As interviewees confirmed, these include an evolving supply chain development programme to expand regional (Wales) procurement opportunities, initiatives to increase the visibility and brand recognition of lower tier suppliers, and targeted talent development measures such as a skills academy. The development of a sustainable membership model for CSconnected has also been prioritised to ensure the initiative's long-term viability beyond the current available funding.

Several recent investments have been catalysed by pre-existing collaborations. For example, Cadence Design Systems' entry in 2025 was underpinned by a research partnership with the CSA Catapult, while Siemens' decision to establish an innovation centre in 2023 was linked to complementary expertise within the regional industry in power electronics. The promotional activities of CSconnected have been credited by stakeholders with enhancing the emerging cluster's international profile, including improving the visibility of local subsidiaries with parent MNEs, and facilitating these new relationships.

Overall, the South East Wales semiconductor industry represents an emerging and distinctive industrial ecosystem, characterised by a combination of large-scale manufacturing, world-class R&D facilities and coordinated public–private governance. Its evolution since the late 2010s has been driven by a combination of strategic public investment, targeted inward investment attraction, and the deliberate creation of institutional and infrastructural platforms for innovation (Munday et al., 2024b, 2025).

4.2. Path development and strategic coupling: from post-industrial legacy to high-tech integration

This section seeks to address the extent to which Wales's post-industrial legacy influences its current ability to integrate with a semiconductor GPN. To some extent, the South East Wales semiconductor industry demonstrates both path dependence and path creation elements with three evolutionary periods highlighting how regional assets have been strategically coupled with global semiconductor production networks.

4.2.1. Path dependence and regional assets

Wales's integration with semiconductor GPNs builds partially on existing regional capabilities, consistent with EEG's emphasis on related diversification (Boschma, 2024). Interview participants from the four long-standing firms – KLA, IQE, Vishay International and Microchip – emphasised how historical electronics capabilities dating from the 1960s–70s provided a foundation of technical knowledge and industrial infrastructure that facilitated subsequent semiconductor specialisation. Firm representatives described how their firms, despite multiple ownership changes and product evolution, maintained technical competencies, such as those at Newport Waferfab (now Vishay), which proved essential for advanced semiconductor manufacturing:

> The long-term survivability of the plant can be attributed to a 'family culture' at the plant which has evolved over many years … it's not what we do, it is the people and you cannot sell the site unless performance is strong.
> (industry representative)

Wales's post-industrial legacy provided strategic infrastructure assets that eventually proved essential for semiconductor development, as detailed by both firm interviews and regional policy officials. Firms in

the semiconductor value chain require their suppliers to operate at sites that pass a series of technical criteria. The IQE Foundry facility highlights this dynamic, with regional development officials indicating how the Imperial Park site for the foundry at Newport had been: 'empty for around 20 years after being originally developed at a high specification for the LG [South Korea] investment' (regional development official).

Industry interviewees close to the foundry development argued that this legacy infrastructure reduced entry barriers for subsequent semiconductor investments, demonstrating how previous FDI created re-purposable high-specification industrial assets.

Interviews with industry leaders revealed, however, that the regional semiconductor industry's evolution also involved significant departures from traditional path dependence. Company executives at leading firms described how the transition from general electronics and silicon to advanced compound semiconductors represented what can be characterised as a form of path creation through the development of entirely new technological trajectories that break from historical industrial patterns (Isaksen & Trippl, 2017; Huggins & Thompson, 2023). Firms detailed how the establishment of specialised epitaxy facilities, cleanroom manufacturing and advanced R&D capabilities represented technological upgrading that generally extended well beyond Wales's traditional industrial base: 'The history of the cluster and the IQE foundry investment was important for our investment and helped the company move into a different part of the value chain' (industry representative).

Interviewees also highlighted the challenges of this transformation through legacy constraints. IQE executives explained how the original site had 'out-of-date tooling' and capacity limitations that required substantial investment to achieve international competitiveness. In addition, the annual survey analysis confirms that few elements of the wider regional manufacturing base share the productivity contribution and resilience of the Welsh semiconductor sector (see below), highlighting the relatively isolated nature of this high-tech success within a broader context of industrial decline.

4.2.2. Strategic coupling mechanisms

Interviews with both policy officials and industry leaders indicated that the strategic coupling between global semiconductor networks and regional assets occurred through deliberate institutional mediation, rather than market-driven processes alone. Regional development officials argued that the period 2015–16 saw the identification of a coordination failure – regional firms operated within different GPN segments (i.e., epitaxy, semiconductor manufacturing, machinery and device packaging) without local integration as well as: 'a failure to integrate with supportive academic research, limiting their collective voice as an industrial group' (regional policy official). Nor was there a single critical firm with a significant extra-regional voice. Policy interviews indicated that this recognition catalysed institutional responses that facilitated deeper strategic coupling.

The period 2016–20 subsequently demonstrated active regional strategies to align local assets with global lead firm requirements, consistent with Fuller and Phelps's (2018) conceptualisation of strategic coupling. Welsh Government and CCR officials explained how the investment in IQE's Newport foundry represented strategic positioning of local infrastructure to meet GPN needs. Furthermore, Catapult leadership highlighted that the establishment of the CSA Catapult created institutional bridging mechanisms between global firms and regional innovation assets. This has, for example, resulted in inward investment by Siemens at the Catapult: 'The Siemens operation came to the Catapult because of local technical expertise … the area felt alive and next to the semiconductor ecosystem and they wanted to be part of the community here' (Catapult representative).

Interviews with KLA executives indicated how their acquisition of SPTS Technologies in 2019, and subsequent investment of over US$100 million in new Newport facilities, illustrated successful strategic coupling from the firm's perspective. These executives explained that 'the new facility spans 18,500m^2 with capacity for up to 750 employees', citing regional talent pools and higher education linkages as factors driving expansion decisions. This demonstrates how regional assets were being positioned to meet global lead firm requirements, with a planned 200,000 square feet of cleanroom facilities, representing substantial territorial embedding of global production functions.

Both the annual survey and interview data confirm successful strategic coupling outcomes through the cluster's growth trajectory. Company executives described recent investments that illustrate deepening territorial embedding (and better embedding of Welsh subsidiaries with parent company networks),

these include Vishay International's £142 million takeover of Nexperia (formerly Newport Waferfab), plus £51 million additional investment, and Cadence Design Systems' joint venture being established in 2025.

4.2.3. Institutional coordination and path creation

Interviews with CSconnected leadership and university partners revealed that the period 2020–25 involved more sophisticated institutional coordination, supported through the UKRI's Strength in Places project. Programme officials described how this initiative facilitated collaborative development projects between private firms, the Catapult and universities, creating coordinated strategies aligning local capabilities with global demands (Torre, 2025):

> Every meeting we have, you know, we've got Welsh Government involved, we've all the industries involved, we've got every education provider involved, sat around one table. … Everyone sits around these tables, has a voice, and they all effectively communicate what they need.
>
> (CSconnected representative)

CSconnected leadership reported that the programme has secured £66.4 million in grant funding since 2020, supporting 242 knowledge transfer events, demonstrating systematic institutional capacity-building.

University leadership at both Cardiff and Swansea described how the integration of research capabilities represents institutional path creation that better positions Wales within global innovation networks. For example, Cardiff University's Institute for Compound Semiconductors operates a 12,000 m^2 Translational Research Hub, while Swansea University officials outlined their Centre for Integrative Semiconductor Materials (CISM) representing a £29 million capital investment in 4200 m^2 of specialist research space. Both expressed ambitions to become a European leader in compound semiconductor innovation, signalling attempts to upgrade regional positioning within GPNs beyond traditional manufacturing functions toward higher value innovation activities. The emphasis here was placed on value to be added to the manufacturing process rather than a singular focus on design:

> Our centre plays a vital role in the South Wales semiconductor cluster particularly for start-ups given the availability of equipment for firms that are under-capitalised. This equipment is all in one place. This is an important function within the cluster and important way through which supply chain development can occur.
>
> (university representative)

Catapult management described how the CSA Catapult serves as an intermediary institution, and has facilitated 20 collaborative projects involving public and private sector partners, creating or safeguarding 650 jobs and advancing 12 projects to Technology Readiness Levels of 6 or above (also see Munday, 2024).

This varied institutional architecture demonstrates more sophisticated coordination mechanisms addressing what da Ponte et al. (2022) identify as critical challenges in managing strategic dependencies within complex GPNs.

4.3. Embeddedness: regional ecosystem robustness and MNE integration

This section addresses the extent to which the Welsh regional ecosystem is robust enough to develop embedded relationships with MNEs. In summary, both the survey and interview data reveal a pattern of 'partial embeddedness' within the South East Wales semiconductor industry, whereby GPNs exhibit selective and uneven integration with regional economic structures.

4.3.1. Limited regional trade integration

The annual survey data spanning the period 2020–24 reveals that despite substantial industry growth (with sales exceeding £500 million and direct GVA of £255 million). The regional semiconductor industry operates largely as what industry participants characterised as 'an island within a regional economy'. Survey findings have consistently shown that just 8% of total industry sales occur within the Wales/rest of UK economy, with over 90% exported to Asia and North America. Interview participants across all firms confirmed this export orientation, while acknowledging that it indicates limited 'forward' linkages to regional and national economies, despite contributing to UK trade balances. To an extent, this pattern reflects what

Phelps and MacKinnon (2000) identify as MNE 'enclave development', whereby there is substantial industrial presence but minimal regional economic integration.

Despite this lack of integration, the majority of interviews with senior management across firms revealed that the semiconductor case differs from traditional branch-plant scenarios in several important respects. Company executives emphasised the presence of substantial R&D functions (survey data for 2024 confirmed 18% of the workforce are engaged in R&D activities), high-value employment (annual surveys show average salaries of £67,765 compared with the Welsh average of £39,301), and high skill levels (company human resources data indicate 40–85% of employees are qualified to undergraduate level), suggesting deeper forms of embedding than typical cost-focused foreign investment.

Analysis of the survey data indicates that the industry's productivity performance is showing a degree of transformative potential within the industry itself. GVA per worker in the Welsh semiconductor industry grew by an estimated 61% between 2019 and 2023 compared with 24% UK-wide productivity growth, indicating substantial value creation. Including multiplier effects calculated from annual survey spending data, the regional cluster supports an estimated 2750 total jobs (1806 direct plus 942 indirect), representing significant regional economic impact despite limited intersectoral linkages, as confirmed through interviews.

4.3.2. Supply chain integration dynamics

The annual survey data on purchasing patterns indicate embeddedness dynamics that extend beyond simple local sourcing metrics. In particular, 'materials and components' constitute between 50% and 95% of total firm purchases, with UK sourcing propensity varying significantly across firms and product categories. The survey analysis indicates substantial import substitution potential, particularly in specialised inputs such as silicon, epitaxial materials, gases and chemicals.

CSconnected programme managers reported active development of local supply chains, with 25 suppliers registered for supply chain events by 2024. Interviews with participating suppliers found that some have made substantial investments to meet cluster requirements: 'CCR's investment supported activities beyond the foundry itself including supply chain development, promoting tighter integration among regional firms' (CSconnected representative).

Interviews with KLA executives highlighted the mechanisms through which deeper embeddedness can emerge over time. These executives described active regional supply chain development strategies to build local supplier capabilities rather than passive sourcing decisions. They explained how they have 'actively encouraged firms in their existing regional supply chain to upskill and grow', leading to investments in cleanroom capabilities, ultrasonic cleaning, and specialised packaging, which are capabilities that extend beyond KLA's immediate requirements to serve broader semiconductor applications (KLA executives).

4.3.3. Supplier upgrading and capability development

Interviews with two KLA suppliers highlighted different trajectories of deepening embeddedness. The first supplier, established in 2005 with approximately 100 employees, evolved from basic metal fabrication to value-added manufacturing serving multiple high-tech sectors. Company executives confirmed that their relationship with KLA drove technological upgrading including cleanroom facility investment and expansion into electromechanical assembly. This represents 'agent-led adaptation', whereby regional firms upgrade capabilities in response to GPN participation opportunities (Lee, 2024).

The second supplier case study highlighted sophisticated embeddedness through supply chain orchestration functions. Company leadership explained how beyond printed circuit board assembly capabilities, their firm provides 'full turnkey solutions including completed sub-assemblies for KLA' and manages complex supplier networks for small electronic components (industry representative). Interviewees again highlighted the development of cleanroom facilities with KLA-specific equipment placement, illustrating co-evolutionary embedding whereby regional suppliers adapt infrastructure to meet specific lead firm requirements while building capabilities for broader market applications.

Both supplier interviews, however, revealed the limits of regional embeddedness in a small-scale economy whereby: 'Advanced manufacturing requirements in "material science, physics, and chemistry" exceed regional supplier capabilities, necessitating continued reliance on external networks for high-value inputs' (industry representative).

This aligns with Phelps et al.'s (2018) observation that strategic coupling in a context such as a lagging region such as Wales often remains limited by scale and capability constraints.

4.3.4. Knowledge and innovation embedding

Interviews with university leadership and research directors revealed that the institutional infrastructure linking global firms with regional universities represents a distinct dimension of embeddedness focused on knowledge transfer and innovation capabilities. Interviewees at both Cardiff University and Swansea University indicate that the new facilities development provides formal mechanisms for global–local knowledge exchange, supporting both fundamental research and translational activities. Furthermore, Catapult facilitates deepened embedding through 'business acceleration support', bridging research capabilities with commercial applications. In general, interview participants indicated that this institutional configuration creates pathways for tacit knowledge transfer and collaborative innovation, which extend beyond traditional customer–supplier relationships. This can be described as a form of multidimensional embeddedness encompassing institutional, social and economic integration (Yeung, 2016).

4.4. Value capture and institutional mediation: leveraging GPN participation for regional transformation

This section considers whether Wales can leverage GPN participation to achieve wider structural transformation in its regional economy. Interviews with industry leaders and institutional managers reveal both significant value capture achievements, and persistent challenges in translating GPN participation into broader regional economic transformation.

4.4.1. Direct value capture achievements

The annual survey data and interviews with human resources and finance directors across firms reveal substantial regional value capture from semiconductor GPN participation that extends beyond direct industry employment and sales. Interview participants from industry firms also reported changes in employment characteristics such as R&D employment and increased in educational achievements of employees. Company managers suggested that this represents a substantial upgrade from traditional Welsh manufacturing employment profiles and demonstrating successful positioning within higher value GPN functions.

4.4.2. Institutional mediation and coordination

Effective value capture has required sophisticated institutional mediation addressing coordination failures inherent in complex multi-actor development processes. The Wider Investment Fund (WIF) investment in IQE's foundry (see above) represents innovative public sector engagement that moves beyond traditional subsidy models, toward co-investment approaches, which align public and private interests while ensuring returns to regional stakeholders. Furthermore, the CSconnected initiative demonstrates institutional mediation at multiple scales, coordinating regional, national and international funding streams. An interview with one firm suggested that this coordination has facilitated collaborative projects between firms, universities and intermediary organisations while building, 'national and international standing of the regional industry' (industry representative).

4.4.3. Supply chain value capture strategies

Recognition of limited regional trade integration has prompted institutional responses designed to capture greater value from existing GPN participation. A structured programme launched in 2025 by CSconnected and CCR to 'expand the semiconductor supply chain in South East Wales' represents systematic attempts to increase both regional purchasing and sales within the Welsh and UK economies. The emphasis on both upstream (supplier) and downstream (customer) supply chain development reflects more sophisticated understandings of value-capture opportunities. Targeting downstream sales to UK-based technology firms could provide additional value, support UK-based employment and raise UK productivity, while creating opportunities for higher value product exports that improve trade balances.

4.4.4. Limitations and structural constraints

Despite institutional mediation successes, structural constraints limit broader regional transformation potential. The industry's continued export orientation and limited local sourcing reflect what Capello and Dellisanti (2024) view as 'factory region' dynamics consisting of substantial manufacturing presence without comprehensive regional economic integration. The emerging cluster represents a 'bright spot' in Welsh manufacturing but demonstrates limited spillover effects to other sectors of the regional economy. As noted above, few elements of the regional manufacturing base share the productivity contribution and resilience of the Welsh semiconductor sector, indicating relative sectoral isolation within a broader context of industrial decline. The high export dependency also creates vulnerability to global market volatility, despite the economic benefits generated (Munday et al., 2024a).

GPN logic often resists spatial consolidation unless aligned with firm competitiveness priorities, as evidenced by continued reliance on Asian and North American supply chains despite regional development incentives (Yeung, 2015). The absence of regional semiconductor industry trade, and the dominance of global over regional linkages, suggests that territorial embeddedness remains partial and uneven, even with active institutional intervention. Regional-scale constraints fundamentally limit supply-side development potential, as acknowledged by industry participants who understand local sourcing to consist of the UK-based supply chain rather than purely regional networks: 'There was a limited supply of components to be purchased locally and fundamentally in Wales there was a low level of materials available for their purposes' (industry representative).

Despite the CSconnected programme registering 25 suppliers for supply chain events, the relatively small scale of the industry within Wales's overall economy constrains broader transformative impact.

4.4.5. Evolving value capture opportunities

Changing global contexts may enhance value capture potential through reshoring and friend-shoring trends driven by geopolitical tensions in semiconductor GPNs. The pressure placed on the globalised product chains of the semiconductor industry by growing global trade challenges may create opportunities for increased regional and national supply chain integration. The interviews with semiconductor firms indicate that the potential for the downstream supply of semiconductor products by the industry to UK firms is becoming increasingly important, which suggests evolving value capture opportunities that align regional capabilities with changing global production imperatives:

> The presence of this company seems to strengthen the cluster greatly because it produces goods relevant to many verticals around the cluster and it is easier for the cluster members in South Wales to work together on research and development because they are in different parts of the value chain.
>
> (industry representative)

Such developments could transform current 'factory region' dynamics toward more integrated regional innovation systems that capture greater value from GPN participation, while supporting broader economic transformation objectives.

5. Discussion and conclusions

The case of the semiconductor industry in South East Wales indicates how global forces, local capacities and institutional dynamics each impact on the regional development potential of highly globalised industries. The case demonstrates that GPNs are locally embedded and may be regionally leveraged. The analysis confirms the GPN 2.0 view (Yeung, 2024; Yeung & Coe, 2015) that regional economies are not just passive recipients of global production but can actively mediate integration through institutional and firm-level strategies. Although the findings point to a 'strategic coupling' process (Yeung, 2024; Yeung & Coe, 2015), demonstrating how MNEs can selectively integrate with local suppliers, they also indicate that coupling can remain limited by regional scale and capability constraints (Phelps et al., 2018).

From a regional development perspective, the analysis has critiqued the assumption that attracting high-tech, high-value industries automatically translates into broader regional development dividends. It highlights that the South East Wales semiconductor industry largely functions 'as an island within a regional economy'. This reconfirms the perspective that industrial presence alone is likely to be insufficient for

regional transformation without robust supply chain integration and institutional coordination (Fuller & Phelps, 2018; Martin, 2021; Pike et al., 2017). Regional economic gain is contingent not just on the presence of anchor firms, but on their willingness and capacity to engage local and national supply networks. The findings suggest a need for regional policy frameworks that go beyond firm attraction to enable systemic regional integration, resonating with repeated calls for place-sensitive and institutionally coordinated strategies (Rodríguez-Pose, 2021).

From the EEG perspective, the development of the South East Wales semiconductor industry reflects a technological path creation process (Martin & Sunley, 2006). This is building on Wales's prior capabilities and institutional infrastructure in electronics but is branching into more advanced semiconductor specialisms. Nevertheless, the analysis indicates the uneven co-evolution between the semiconductor industry and its South East Wales regional context. Consequently, using Capello and Dellisanti's (2024) typology, South East Wales still predominantly remains a 'factory region'. Although knowledge flows and collaboration with regionally situated universities has strengthened, supply-side integration remains limited and broader regional innovation diffusion remains weak. While the role of core firms within the regional semiconductor industry in encouraging upskilling suggests agent-led adaptation (Lee, 2024), the lack of broader regional semiconductor industry trade indicates the South East Wales semiconductor industry has reached, in the context of GPN 2.0 literatures, a stage of only 'partial embeddedness'.

Supply chain development in the semiconductor industry is clearly not easy, given that the existing global system of semiconductor supply chains tend to be controlled through trade agreements and technological monopolies (Capri, 2025). The GPN integration of smaller scale regional and national semiconductor industries is complex and difficult to navigate (Coe et al., 2008). Nevertheless, if the UK as a whole is to successfully revive its semiconductor industry, along with more effective local upstream supply chains, existing incumbents will need to become far more successfully integrated into such networks. Regions with limited existing value chain capability, such as Wales, are more likely to access knowledge and technology externally, often facilitated by MNEs (Huggins et al., 2019). In this respect, the South East Wales semiconductor industry, with its hosted range of embedded MNEs, offers an opportunity to facilitate the upgrading of regional industrial functions. Continuing to strengthen institutional mediation mechanisms will be critical to the success of this process.

In addressing the research questions, the case provides wider insights into both the opportunities and challenges facing lagging regions seeking to develop new growth paths within GPNs. It demonstrates that while peripheral regions have traditionally been relegated to low-value activities in global value chains, strategic interventions can create opportunities for industrial upgrading and path creation. Three key lessons emerge for regional development theory and practice. First, the case reveals how regions can leverage technological niches and specialised capabilities to move beyond simple assembly operations toward higher value R&D and manufacturing activities. This challenges assumptions about the relatively fixed hierarchical nature of GPNs and suggests possibilities for peripheral regions to develop distinctive positions. Second, the case illustrates the critical importance of institutional embeddedness in facilitating new path development. Unlike the traditionally footloose nature of MNEs in Wales, semiconductor firms have demonstrated deeper engagement with regional institutions, universities and supply chains. This embeddedness, supported by targeted state initiatives and market incentives, has been essential for building the collaborative relationships necessary for industrial upgrading. Finally, the experience highlights a fundamental tension that lagging regions must navigate: how to strengthen domestic and regional supply chain integration while maintaining the international connections that are essential for participation in GPNs. Success requires striking a balance between building local capabilities and preserving the openness that allows regions to access global knowledge, markets and investment. For Wales and similar regions, the semiconductor case suggests that new path creation is possible, but requires sustained commitment to building institutional capacity, fostering embeddedness, and managing the complex relationship between local development and global integration. The test will be whether these foundations can support continued upgrading and resilience in an increasingly competitive global economy.

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Ethics statement

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