Welsh Economy Research Unit
Yr Uned Ymchwil i Economi Cymru

CSconnected

Annual Report: Compound Semiconductor Cluster in South Wales Final Draft 10th January 2022

Welsh Economy Research Unit
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Table of Contents

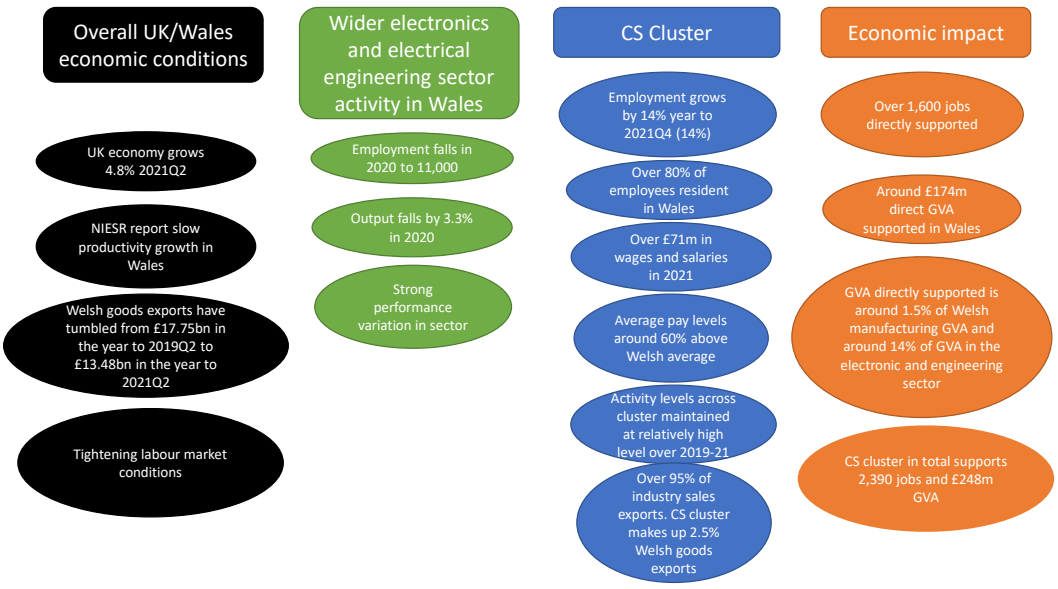
Key elements of the 2021 CS cluster report:

This is the second in a series of annual reports considering the economic effects connected to the development of the compound semiconductor (CS) cluster in Wales. The report considers the regional context of CS cluster development and how its contribution compares with other parts of the Welsh economy. The work forms part of the research and evaluation function surrounding the UKRI Strength in Places Fund £25m investment into CSconnected.

The report provides an update on the regional economic context surrounding CS cluster development in 2021.[1] It further considers the direct and indirect economic activity in Wales supported by CS cluster activity. The final section provides some conclusions on the expected development of CS cluster activity in Wales and key variables affecting cluster growth.

The Figure below presents some of the key elements of this report.

Summary of findings



[1] See Report (csconnected.com)

1. Introduction

This report is an annual update which considers the economic activity supported in Wales by the cluster of firms and institutions that form part of CSconnected activity funded by the *Strength in Places Fund* managed by UK Research and Innovation (UKRI). The consortium consists of partners including: Cardiff University (lead), Swansea University, IQE, SPTS, Nexperia (previously Newport Wafer Fab), Microchip, Microlink Devices, the Compound Semiconductor Centre, the Compound Semiconductor Applications Catapult, the Cardiff Capital Region (CCR) City Deal and Welsh Government.

In the Strength in Places Fund (SIPF) application process Professors Robert Huggins and Max Munday and Dr Annette Roberts were commissioned in May 2019 to analyse the evolution of the cluster since its genesis in 2015, and then to analyse how far the further development of the cluster, as supported by the CS Connected SIPF application, would support activity in the regional economy, and meet the more persistent economic challenges facing the regional economy. As part of this work, the research team have provided an estimate of the economic activity supported by the consortium partners in both 2019, and 2020.

To build on these earlier reports, this study examines the economic activity supported by the CS cluster in the final quarter of 2021. The report also provides contextual information through which to better understand the economic contribution of the cluster. During 2021 trading conditions for much of Welsh manufacturing have remained difficult in the wake of uncertainties surrounding the Brexit transition process and the problems caused by Covid-19 and a series of lock downs.

A series of data sources have been used to compile this report. Uppermost here is information provided by the cluster participants in terms of their output, employment, wages and salaries, expenditure and exports. This is supplemented in some cases by data from the annual accounts and financial statements of organisations involved in the cluster. Moreover, during the period September-December 2021 it was possible for members of the research team to undertake site visits to five of the CS cluster sites to discuss economic impact themes.

This report presents estimates of the Welsh economic activity supported by the CS cluster. It is important to stress that this is an estimate for 2021Q4 as the companies involved in the cluster have different financial reporting year ends. In addition, the analytical process requires assumptions to be made about the gross value added directly and indirectly supported by CS cluster operations. In this analysis employment, output and exports are not linked to individual CS cluster organisations. Much of the data provided by the cluster participants is commercially confidential and is therefore reported in aggregate form so as not to identify individual firms or organisations.

Part of the analysis which follows comprises an economic modelling exercise to examine how the CS cluster supports activity in other parts of the Welsh economy. Here the Welsh Input-Output framework is used, with this representing a basic economic model of the Welsh economy. As far as possible in the economic modelling, similar assumptions to previous years of CS cluster analysis are used in respect of the regional multiplier effects of industry activity.

The annual review of economic activity supported by the cluster also serves to inform a series of KPIs for the UKRI funded Strength in Places CSconnected project; these include:

- KPI 1 Direct employment in core cluster firms and new inward investors
- KPI 2 Exports of cluster firms
- KPI 4 Total gross value added supported by cluster activity directly and indirectly

However, elements of this report are also useful to inform the wider evaluation framework of the UK-wide Strength in Places Fund activity being undertaken by Frontier Economics. In this respect the report seeks to address specific Evaluation Questions for the whole of the programme. Specifically:

- *EQ2: Did the SIPF increase the quantity and quality of regional commercial R&I in key industries? To what extent was long-term capacity for such R&I increased? To what extent did this leverage existing local strengths?* [with this review addressing R&D employment in the commercial firms]
- *EQ5: Did SIPF improve the job prospects, in terms of the number, variety and profile of jobs available within the targeted regions? If not, why not?* [with this review examining jobs growth, type of employment and its productivity characteristics]
- *EQ6: Did SIPF increase the skills base and/or alter the profile of skills in targeted regions? If not, why not?* [with this report considering the labour market supply and demand side surrounding the CS cluster]
- *EQ7: Did SIPF funded-activities contribute to improved economic performance, particularly within targeted industries and regions? If so, was the improvement sustained? If not, why not?* [and with this report examining the contribution of the CS cluster activity to the region in the context of the performance of the wider Welsh economy]
- *EQ8: Did SIPF contribute to closing gaps in economic performance across UK regions? If not, why not?* [this report considers the productivity characteristics of businesses in the cluster, with productivity growth considered to be the main means of reducing gaps in regional performance]
- *EQ15: To what extent does the SIPF represent value for money given the overall impact on knowledge, economy and society relative to the size of the investment?* [understanding the growth and performance of the CS cluster is one means of establishing the additionality offered by the CSconnected programme. Informed decisions about the additionality offered by the CSconnected initiative can only be made once the growth and development of the CS cluster are understood].

The next section provides an update on the regional economic context surrounding cluster development in 2021, with the third section providing an estimate of the direct and indirect economic activity in Wales supported by cluster activity. The final section provides some conclusions on the expected development CS cluster activity in Wales in 2022 and key variables affecting cluster growth. The final section also comments on research priorities for better understanding the contribution of the CS cluster in 2022-23.

2. Regional Economic Context

2.1. Introduction

This section of the report focuses on the Welsh economy context during 2020/21. The second part of this section examines the economic information appertaining to the broad economic sectors in which CS cluster activity occurs i.e. standard industrial classifications (SIC) 26 and 27, manufacture of computer, optical and electronic products, and manufacture of electrical equipment. A key objective here is to frame the economic contribution of the CS cluster in the context of recent economic conditions and events.

2.2. Welsh economy context for CS cluster activity

The overarching context for the performance of the Welsh economy through 2021 has been regional and UK-wide efforts to end the Covid-19 pandemic, and to address associated economic and social impacts. These efforts are based on vaccination rollouts, and policies to address the significant economic implications deriving from the mitigation measures and lockdowns that disrupted economic and social activity. Welsh businesses and employees have been beneficiaries of the UK-wide job furlough scheme, but with interventions also targeted on providing firms with working capital support through preferential loans and grants (for example, through strands of the Welsh Government Economic Resilience Fund), but also support to aid firms in innovatory responses to exit the pandemic period as strongly as possible.

Prior analyses have argued that CS cluster activity in Wales has been maintained at a relatively high level in spite of poor recent economic conditions. There was a severe global economic contraction in 2020 (an estimated 3.6% decline in Gross Domestic Product (GDP)). However, most forecasting institutions predicted improved conditions in 2021. For example, the IMF forecast[2] was for a significant recovery in the global economy in 2021 (6% annual GDP growth, this being close to the OECD prediction of 5.8%) and further growth in 2022 (4.9%). This optimism was predicated on some improvement in health outcomes in many developed states in the first three quarters of 2021, but also upon strengthening labour markets.

Economic prospects in Wales link closely to global and UK growth. Economic Intelligence Wales (2021)[3] show that after a GDP fall of 1.5% in 2021Q1, the UK economy grew by 4.8% in the quarter to 2021Q2, reflecting the easing of Covid-19 restrictions. However, UK GDP was still 4.4% below the last pre-pandemic quarter (2019 Q4).[4] The immediate context for CS cluster activity is, however, given by trends in Welsh economic activity. Economic Intelligence Wales (2021) show that GDP figures have been a little better in Wales than in the UK economy since the beginning of the pandemic.

[2] https://www.imf.org/en/Publications/WEO/Issues/2021/07/27/world-economic-outlook-update-july-2021

[3] See Quarterly report November 2021 Q1 ENG.pdf (developmentbank.wales)

[4] https://www.ons.gov.uk/economy/grossdomesticproductgdp/bulletins/gdpfirstquarterlyestimateuk/apriltojune2021

The effects of Covid-19 are captured by quarterly (experimental) GDP estimates for Wales.[5] The latest available figures, showed 0.9% quarterly growth for 2020Q4, following a 14.4% increase in the quarter to 2020Q3 and a 15.2% contraction in 2020Q2.[6] CS cluster activity in Wales in 2021 then needs to be considered in the light of some recovery in economic conditions, albeit with growth in US and Asian markets of greater consequence in the context of overseas sales of the main CS cluster firms.

The UK Government Covid-19 financial support schemes have significantly supported employment, preventing a large decline of the national labour market. Important for CS cluster firm future development prospects has been a recovery in UK labour markets. For example, according to the Labour Force Survey[7] the signs of recovery of labour markets became stronger during the second quarter of 2021. Moreover, redundancy rates have been declining since the latter part of 2020. The unemployment rate in Wales was 4.1% in 2021Q2. For the UK as a whole the period June to August 2021, saw the number of UK job vacancies exceeding 1 million for the first time since records began in 2001, and were almost 250,000 above pre-pandemic levels. While sectors such as transport and storage, and accommodation and food were among sectors with the highest rates of vacancies in 2021, it is unlikely that CS cluster firms will be exempt from these pressures. Relatively high pay rates in the CS cluster might shield against some of these labour supply side pressures. However, it is already the case that there are some skill shortages in the CS cluster (some relating to BREXIT).

A key element of the CSconnected project is to improve the local supply side for CS-relevant skills, and recent labour market trends exemplify the importance of this part of the programme. It is expected that in the light of tightening labour market conditions in 2021-2022 that CS firms seeking to grow in Wales will find difficulty recruiting some grades of staff, and with evidence already of firms having to recruit internationally for some specialist technical grades of staff.

The Strength in Places Fund investment in CSconnected runs through to mid-2024. The contribution of the CS sector firms is increasingly being understood in terms of long term productivity growth challenges facing the local economy. Indeed, in their Summer *UK Economic Outlook*, the National Institute of Economic and Social Research (NIESR) forecasted that Wales will not have recovered to pre-pandemic levels of gross value added (GVA) by 2024Q4. In this context the role of CS cluster firms in maintaining Welsh GVA is important and with growth in the cluster expected in the 2022-2024 period, this at a time when other parts of Welsh manufacturing are expected to be under increasing pressure.

[5] These figures should be treated with caution due to the potential volatility of the data.

[6] https://www.ons.gov.uk/economy/grossdomesticproductgdp/bulletins/gdpukregionsandcountries/octobertodecember2020

[7] https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/bulletins/uklabourmarket/latest

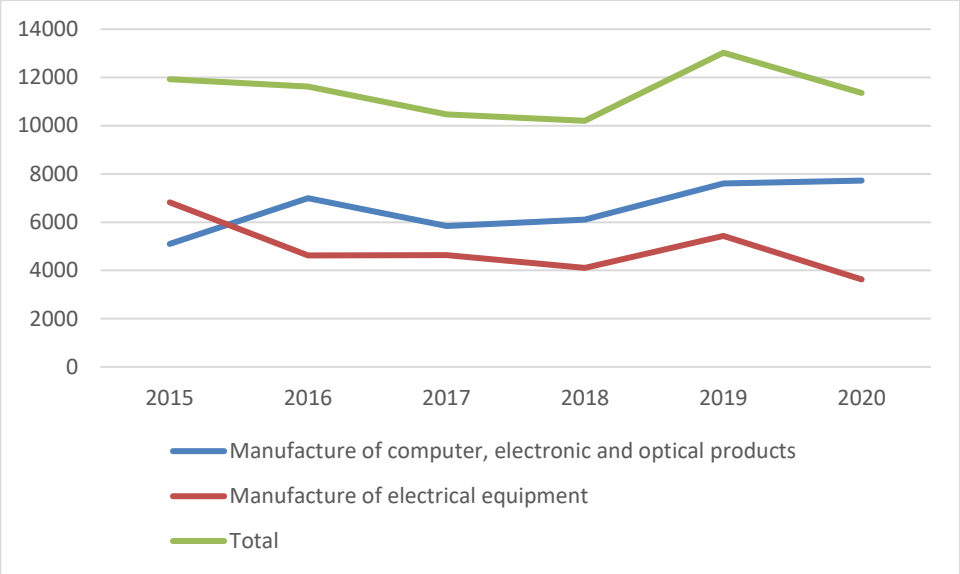
2.3. Recent sector performance in Wales and trade activity

Employment

The majority of the compound semiconductor manufacturing activity in South Wales is within standard industrial classifications (SIC 2007) 26 and 27. SIC 26 and 27 together make-up the Electrical engineering and equipment sector in Wales (defined as SIC 26 - Manufacture of computer, electronic and optical products, and SIC 27 - Manufacture of electrical equipment).

The most recent figures available for employment in these two sectors are from the ONS *Business Register and Employment Survey* and reveal that the number of employees grew from an estimated 11,000 in 2017, to an estimated 13,000 in 2019. In 2020, and as expected, a downturn in economic activity led to some reduction in employment from 13,000 to 11,000. Figure 2.1 reveals the overall trends in the employment of SIC 26 and SIC 27 from 2015 through to 2020.

Figure 2.1 Employment in SIC 26 Computer, electronic and optical products & SIC 27 Electrical equipment 2015-2020



Source: Business Register and Employment Survey

Immediately clear from Figure 2.1.has been that much of the employment loss in the sector as a whole through 2019-2020 was in manufacturing of electrical equipment, and with much of the losses here sustained in electric domestic appliances, batteries and electricity distribution equipment. However, employment in computer, electronic and optical devices grew slightly in 2020. Those parts of SIC 26 in which businesses such as Nexperia, IQE, Microchip operate (i.e. SIC 261 Manufacture of electronic components and 262 - Manufacture of loaded electronic boards) saw employment maintained in 2020 at 2,350 people. It is concluded here that the maintenance of production activity linked to strong export markets of the CS sector firms played a role in maintaining employment levels in the wider Wales electrical engineering sector.

In 2020 it was estimated that CS cluster employment as a whole was around 1,400 people (this including some elements of activity outside SIC 26-27 i.e. higher education, R&D services). Cluster employment in the final quarter of 2021 is estimated to be around 1,600 i.e. around 14% growth in the year to 2021Q4, and with CS sector activity making a stronger contribution to overall electrical engineering and equipment sector activity through time. CS sector manufacturing employment is currently estimated to account for over 10% of Wales' total employment in electrical and electronic engineering.

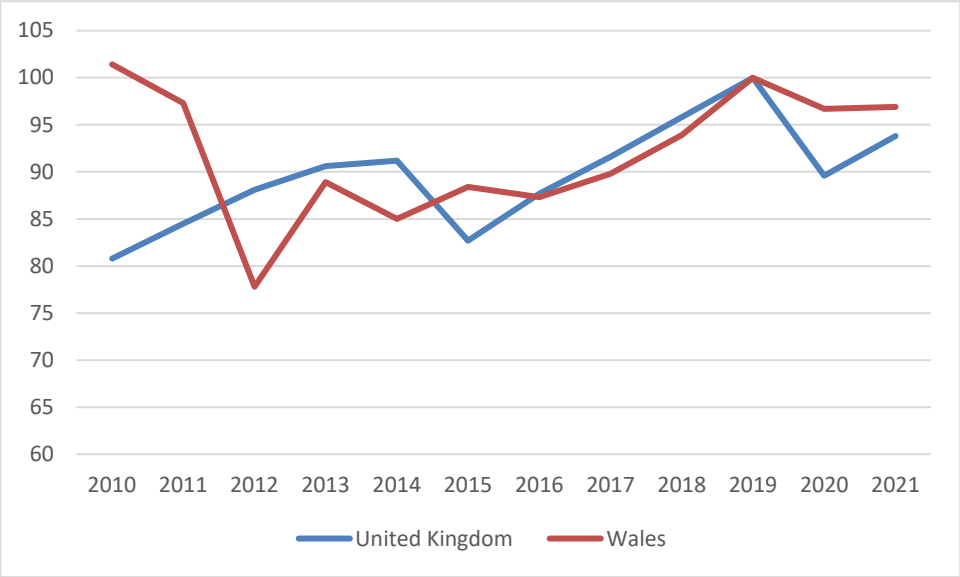
A number of other points can be made in respect of CS cluster employment:

- Virtually all of the employment provided in the CS cluster is full-time as opposed to part-time.
- An estimated 84% of CS cluster employment is provided for employees resident in Wales. It is noted here that the largest employment plants in the CS cluster are sited close to labour markets just over the border in England.
- Wages and salaries in the CS cluster are relatively high. The report estimates that the non-HEI parts of the CS cluster paid out around £71m in wages and salaries in 2021, with the average gross wage being around £52,000 (with a range in cluster organisations excluding HEI of an estimated £40,000 to £82,000). By comparison mean gross annual pay in Wales as a whole in 2021 for full time workers was around £32,700 according to the Annual Survey of Hours and Earnings, meaning average pay levels in the CS cluster are some 60% above the average and with this reflecting the skills levels in the sector. It is difficult to gain accurate information on wage inflation in the CS cluster, but in some manufacturing parts of the CS cluster, wages are estimated to have increased by more than 10% between 2020 and 2021 reflecting in part growing shortages of operatives and higher engineering grades.
- Given expansion plans already announced by firms such as Nexperia and KLA (SPTS) there is some expectation that wage levels across the CS cluster will continue to increase in 2022, and with skills shortages in some parts of the manufacturing cluster becoming more acute.

Output

Figure 2.2 shows recent trends in the index of production output in the Welsh and UK computer and electronic products sectors. Note the data for '2021' in this Figure only includes information up until the end of 2021Q2. This is an index of output where 2019 values equal 100. The CS cluster contributes to output in this sector. Immediately evident here is the sharp fall in UK output in the sector through 2020. Here UK output in the computer and electronic products sector fell by over 10% in 2020 before staging a recovery in the first half of 2021. In Wales the fall of the index of output in computer and electronics products was not as sharp as in the UK as a whole i.e. falling here by 3.3% in 2020. Encouraging here is that the index value of Wales in the first half of 2021 was only 3% below pre-pandemic levels revealing that the sector as a whole has weathered the Covid-19 and Brexit period better than some sectors such as Transport Equipment which has seen output fall very sharply in the period since 2019.

Figure 2.2. Index of Computer and Electronics Products Output Wales and UK 2010-2021Q2 (2019=100)



Source: Derived from StatsWales

It is not possible to separate out the firms involved in the CS cluster from the index of output data shown in Figure 2.2. However, it is likely that the relatively strong performance of CS cluster firms in the 2019-2021 period reinforced trends in the Welsh index figures shown in Figure 2.2. For example, activity levels in the CS cluster were maintained at a relatively high level over the three years 2019-2021 in spite of poor overall trading conditions in much of Welsh manufacturing. Employment in the CS cluster has also been maintained over the same period, and with evidence of employment growth in the parts of the cluster focused on manufacturing activity.

Productivity

There are some difficulties estimating even basic productivity numbers for the CS cluster. Some information is available from the Office for National Statistics on levels of gross value added in Wales for sectors SIC 26 (Computer, electronic and optical products) and SIC 27 (electrical equipment). However, these sectors cover very different types of manufacturing activity, with SIC 26 including basic electronic components as well as complex semiconductor manufacture and epitaxy. Figure 2.3 shows GVA in current prices for these two sectors for 2019 together with estimated employment levels from the ONS *Business Register and Employment Survey*.

Figure 2.3 Estimated GVA per Employee in SIC 26 & SIC 27 2019

Sector	Gross value added 2019	Employees 2019	Estimated Gross value added per employee
SIC 26 Computer, electronic and optical products	£969m	7,610	£127,300

Sector	Gross value added 2019	Employees 2019	Estimated Gross value added per employee
SIC 27 Electrical equipment	£295m	5,425	£54,400
All Welsh manufacturing	£11,265m	133,800	£84,200

Source: Derived from ONS Regional Accounts GVA at Current Prices by Industry and BRES (from Nomisweb).

GVA per employee is not the best measure of productivity as it does not account for the efficiency of the other factors of production beyond labour inputs. However, some points can be made here. The figures for GVA per employee are averages for these broad sectors. There is every indication that these numbers might be conservative for parts of the CS cluster. This conclusion is based on the relatively high level of earnings in the sector. It is particularly difficult to gauge the level of GVA directly supported in the sector because of some uncertainty surrounding regional surpluses made in the CS cluster.

Allowing for the fact that employment in the CS cluster covers a series of SIC sectors (i.e. beyond SIC 26-27) it is estimated that the Welsh gross value added per employee supported by cluster activity in 2021 is around £109,000. In 2021 total GVA directly supported by the sector is estimated at £174m.[8]

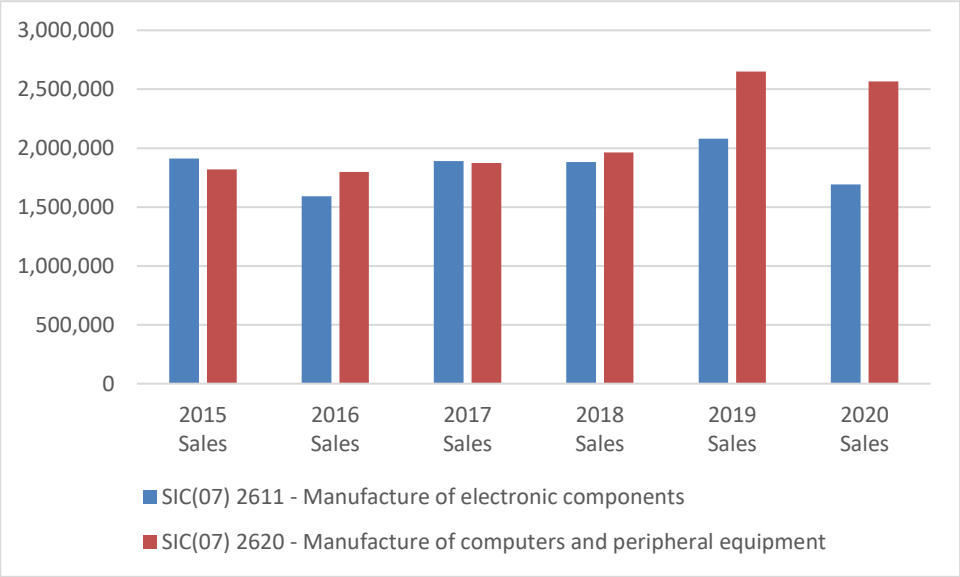
Trade

While UK trade has been damaged by Brexit and Covid-19 there is some evidence that overall sales of electronic components, and manufacture of computers and peripheral equipment held up comparatively well during 2020. This is in part shown in Figure 2.4 which shows UK sales trends in these sectors for the period 2015-2020 (the latest available data).

In Wales, the CS cluster has been an important contributor to regional sales but also to overseas trade for many years. However, the contribution of the CS cluster to Welsh exports has become more marked during recent years as a result of both Brexit and latterly Covid-19. Wales total overseas exports declined sharply in 2020 but with some sectors operating in much more difficult export markets than others. Figure 2.5 shows sharp decreases in the exports of the important Machinery and Transport sector in Wales over the period 2019Q2 to 2021Q2. Indeed the overall value of Welsh goods exports has tumbled from £17.75bn in the year to 2019Q2 to £13.48bn in the year to 2021Q2 (the latest data)

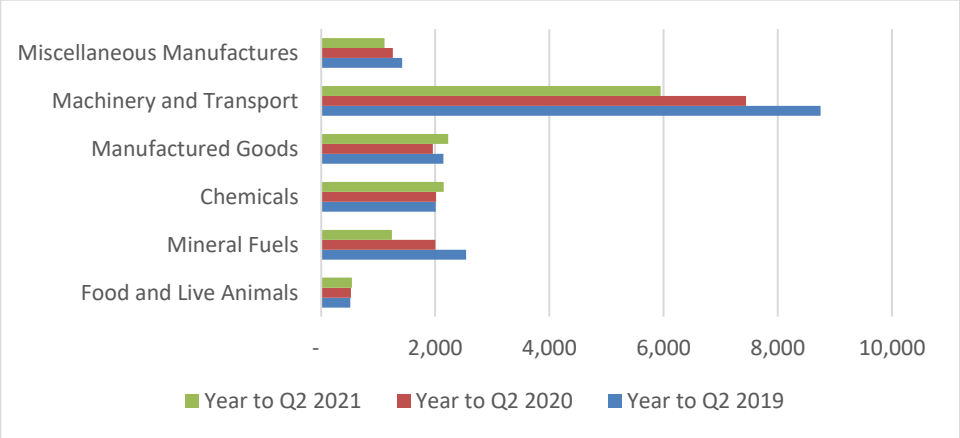
[8] This is an increase from figures estimated for 2020. This increase is accounted because of an increase in sales and employment in the CS cluster but also reflects some revision in the estimates of GVA per employee for key parts of the CS cluster.

Figure 2.4 UK Manufacturing sales: Electronic components, computers and peripheral equipment (SIC 2611; 2620)



Source: See ONS Prodcom Data [UK manufacturers' sales by product - Office for National Statistics (ons.gov.uk)]

Figure 2.5 Value (£m) of Welsh Goods Exports: Selected Sector 2019-2021



Source: HMCE Regional Trade Data

Within the CS cluster of Welsh firms, exports have been maintained in line with overall sales. For example, total sales in the manufacturing elements of the CS cluster in 2021 were around £368m. It is estimated that during 2021 96% of the value of these sales was exports, and with the vast majority in value destined for markets outside of the EU. In the first half of 2021 exports from the CS cluster firms made up an estimated 2.5% of total Welsh exports. As with CS cluster sales, exports values were maintained at a high level over the whole 2019-21 period.

The next section examines the wider economic impact in Wales of CS cluster activity.

3. CS Cluster - Economic contribution to Wales in 2021

3.1. Introduction

This section of the report updates the analyses undertaken in 2019 and 2020 seeking to provide a current estimate of the economic activity of Wales supported by the CSA. Recall that information in this section is reported for the CS cluster as a whole which currently includes: SPTS Technologies, Nexperia, IQE, Rockley Photonics, Microchip, Microlink Devices, CSA Catapult, and CS Centre. The estimates for 2021Q4 also take account of higher education sector employment in Swansea and Cardiff Universities that are linked to the CS cluster.

It is important to reiterate here that the gross value-added supported numbers are estimates. While data was available from the industrial partners in respect of employment and output, direct GVA associated with this employment and output is estimated using a variety of sources including the ONS *Annual Business Survey, ONS Regional gross value added (balanced) by industry*[9] and the *Business Register and Employment Survey (*accessed through NOMIS*).* The derived estimates take into account that GVA per full-time employee in the consortium will vary by industry, for example with developed GVA per FT employee estimates varying between SIC 26 and 27 (SIC 26 Manufacture of computer, electronic and optical products, and SIC 27 - Manufacture of electrical equipment), and varying again in the case of any activity supported in the higher education sector.

Finally, this section also provides an estimate of how far the activity of the consortium members supports other activity in the Welsh economy through their supply-chains. This analysis was assisted by information provided by consortium members in respect of their purchasing patterns, in particular information in respect of what firms are able to purchase in Wales. Clearly, the most important aspect of local purchasing is labour inputs, with the consortium activity providing wages and salaries that are spent in the local economy, and which themselves support economic activity indirectly.

The modelling of indirect activity supported in the Welsh economy is also pertinent to the wider evaluation questions surrounding the UKRI Strength in Place Fund. For example:

- *EQ5: Did SIPF improve the job prospects, in terms of the number, variety and profile of jobs available within the targeted regions?* Only by examining indirect effects in the targeted economy can the full range of employment and opportunity supported by the CS cluster be understood, and then activity in the cluster supported by the SIPF.
- *EQ7: Did SIPF funded-activities contribute to improved economic performance, particularly within targeted industries and regions?* To understand this CS cluster activity needs to be related to the wider target economy.
- *EQ8: Did SIPF contribute to closing gaps in economic performance across UK regions?* In developing arguments here it is necessary to understand the full range of economic effects connected to CS cluster growth across the region.

[9] See Regional gross value added (balanced) by industry: all ITL regions - Office for National Statistics

To estimate the indirect (or multiplier) consequences of the compound semiconductor cluster activity it is necessary to have a picture of the local economy that specifies how various industry sectors 'fit together' in terms of their trading relationships. This then allows the effects of activity in one sector to be traced through the entire local economy. The most comprehensive picture available of the Welsh economy is an Input-Output table. Further description of the Welsh Input-Output project, its strengths and limitations, can be found in (Jones et al., 2010).[10]

The approach adopted here involves estimating direct employment, output and gross value added connected with current cluster operations. The indirect (supply chain) and induced (household spending) effects connected with this activity are estimated through the use of employment and GVA multipliers derived from the Welsh Input-Output tables. Multipliers used were adjusted to take account of features of the specific firms in the cluster and with analysis also incorporating information from the firms showing their local purchasing linkages (and the direction of their sales).

3.2. Impact headlines: direct effects

Revisiting some key elements of Section 2. In the final quarter of 2021 the compound semiconductor cluster employed an estimated 1,600 full-time equivalent employees. Importantly, the vast majority of employment provided by the cluster is full-time as opposed to part-time.

It is noted that cluster employment was estimated at 1,347 in 2018, 1,483 in 2019, 1,407 in 2020 and 1,602 in 2021. Each of the manufacturing members of the CS cluster saw increases in employment in the year to 2021Q4. Moreover, there is some expectation that employment will increase into 2022 in line with investment plans announced by firms such as Nexperia and KLA (SPTS).

The estimated gross value-added per full-time employment within the compound semiconductor cluster firms and organisations in 2021 is estimated at around £109,000. Around this estimate there is some variation in parts of the cluster. For example, in SIC 26 GVA per FT employee is estimated to be around £127,300, while in SIC 27 it is estimated at £54,400. These estimates are likely to be conservative with some parts of CS cluster featuring particularly high wages and salaries which form an important component of industry GVA.

The GVA directly supported by the cluster of firms and institutions is estimated in the year to 2021Q4 at £174m.

[10] https://www.cardiff.ac.uk/__data/assets/pdf_file/0010/698869/input-output-tables-2007-final-30-6.pdf

It is useful to contextualise these numbers in terms of the GVA generated by all Welsh manufacturing. The latest available data for 2019[11] reveals that Welsh manufacturing generated some £11.27bn of GVA and the Computer, electronic, optical and electrical engineering parts of Welsh manufacturing generated £1.26bn of GVA. It is accepted these numbers are for 2019 but **in this context the compound semiconductor cluster GVA directly supported is likely to account for around 1.5% of Welsh manufacturing GVA and around 13.8% of GVA in the more tightly defined electronic and engineering sector.**

The CSconnected project aims to increase the embeddedness of the compound semiconductor firms in the regional economy. This occurs through deepening research and education links with the higher education sector. But a key component is also how far CS cluster members are able to purchase goods and services in the local economy. Here the 'local economy' is defined as Wales, but the understanding of local economy will vary from firm to firm. Clearly a major part of locally purchased inputs is labour, and CS cluster employees resident in Wales spend money on Welsh goods and services which supports other economic activity. The economic modelling framework estimates these induced income effects occurring through Welsh household spend.

However, the CS cluster firm and organisations also purchase goods and services in the local economy. Typical locally made purchases within the CS cluster include:

- Lease/rental of property and business rates
- Utilities and telecommunications
- Maintenance and repairs
- Financial and business services
- Training and development spend.

Also, selected CS cluster firms purchase production materials such as silicon and epitaxy, industrial gases, chemicals, PPE and masks in Wales. These purchasing patterns are important. For example, some of the local purchases are to industries that have also have relatively high productivity characteristics.

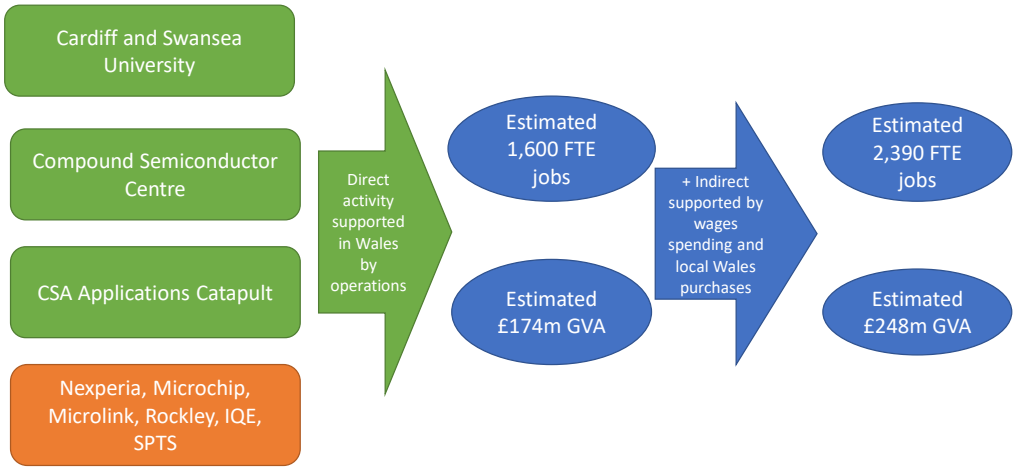
As the above analysis suggests CS cluster members directly support around £174m of GVA and 1,600 full-time equivalent employees. Each cluster member varies in how far it supports activities in local providers of goods and services in Wales, and clearly an expansion of indirect economic effects caused by consortium member regional spending will work to reinforce the importance of the cluster.

Using the Welsh Input-Output framework it is estimated that the cluster, through its purchasing of regional goods and services, and its payment of wage incomes, supports a further £74m of GVA in the Welsh economy. Then each £1m of GVA directly generated in the CS supports an additional £0.42m of GVA elsewhere in the Welsh economy. Overall, this results in the cluster supporting directly and indirectly an estimated £248m of Welsh GVA.

[11] See ONS Regional industry GVA estimates Regional gross value added (balanced) by industry: all ITL regions - Office for National Statistics

Similarly, while the cluster directly supports around 1,600 FTE jobs, it supports an estimated further 790 FTE jobs through its purchasing and payment of wages and salaries i.e. every 1 FTE job in the cluster is connected to an estimated 0.49 of an FTE job elsewhere in the Welsh economy. In total, therefore, the cluster in 2021 could be associated with as many as 2,390FTE jobs in Wales.

Figure 3.1 Economic activity supported by the Compound Semiconductor Cluster (2021Q4)



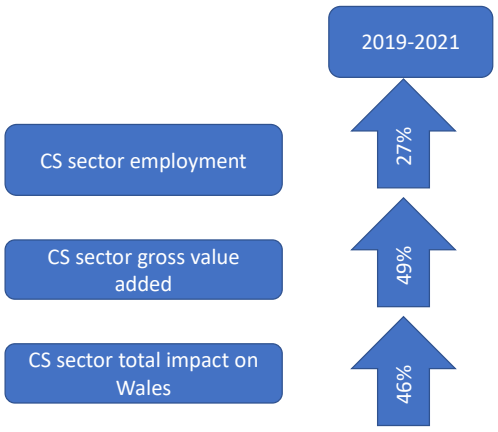
Note: Activities of the main manufacturing firms and other CS Connected members are combined for commercial confidentiality reasons. While direct employment and turnover information was provided by cluster firms, the estimates of GVA/employee were informed by Regional Accounts Current Price estimates of Industry GVA for Wales (SIC 26, 27) and overall Welsh employment estimates in these same industries. Indirect and household effects were estimated using multipliers developed from the Welsh Input–Output tables for SIC 26 and SIC 27, but with some adjustment to multiplier values to allow for some purchases and sales between firms. It is noted that the firms mentioned in this Figure do not share all the characteristics of the wider sector – particularly in the case of SIC 26. Multiplier estimates are therefore indicative. For the cluster firms, multiplier effects through supply chains in Wales are currently quite limited because of low local purchasing, but with the multiplier effects through wage spending higher because of the relatively high wages and salaries paid in firms in the cluster.

4. Conclusions: the impact of the CS cluster

4.1. The overall picture

While 2020-2021 has been an exceptionally difficult time for Welsh manufacturing, the CS cluster appears to have fared better than most in terms of the maintenance of employment, sales and export activity. Figure 4.1 takes the whole of the period 2019-2021 and shows that CS cluster employment has grown by over 25% in this period, while GVA directly supported and total economic impact has increased by over 50%. Note that these figures are for the CS cluster as a whole and with some parts of cluster seeing falling sales in 2021. Output has been maintained because of strong overseas demands for the products produced in Wales, but with this reinforced by consumer demands for electronic goods in which the outputs of the CS cluster.

Figure 4.1 Development Summary CS Cluster 2019-2021



While the comparative strengths of the sector have been exemplified in 2021 there are a series of issues to be mindful of in the coming period. Overall prospects of the sector tie to the strength of consumer demand and global economic prospects to 2025, which still contain elements of uncertainty concerning the full ramifications of the Brexit transition, the longevity of the Covid-19 pandemic, as well as the knock-on volatility being experienced across the global semiconductor industry. However, there are a series of more local factors of interest:

- This report has provided evidence of tightening labour market conditions in Wales, and in the CS cluster. While operating cost conditions in Wales are lower than they are in many other parts of the world for this industry group, sharply rising wages could undermine this advantage.
- The close of 2021 has seen a UK Government security review in respect of the ownership of Nexperia at Newport. A different model of operations at Nexperia is expected to mark a departure from the Foundry model. This will create challenges for selected inward investors

for whom the presence of a CS Foundry was critical. However, there is also the possibility of new foundry activity being developed to meet these requirements which could lead to an increase in CS cluster output and employment in the near future.

- 2022 will see the completion of the new **ICS Translational Research Hub on the Cardiff University Maindy Campus ande there will be significant new capacity for research with the completion of the CISM Building** on the Bay Campus at Swansea offering new capacity for CS research, technological and process development. This is expected to result in some uplift for employment in the HEI element of the CS cluster.
- Parts of the cluster have already announced expansion plans in the period to 2024 including KLA-SPTS in Newport. Critically for Wales expansion activity among CS cluster members is involving HQ-type functions which will further embed the cluster into the Welsh economy.

Figure 4.2 summarises both the opportunities and strengths of the CS cluster in Wales.

4.2. Wider evaluation questions

At this stage it is not possible to evaluate the long run impacts of the Strength in Places Fund CSconnected project. However, some comments can be made in respect of the CS cluster and the general evaluation questions around the UKRI Strength in Places Fund. It is accepted that it is too early to consider the precise role of the Fund. However some comments are provided here alongside selected of the UKRI SIPF Evaluation Questions as follows.

EQ5: Improvements in job prospects, in terms of the number, variety and profile of jobs available within the targeted regions?

This annual review reveals that job numbers have increased in the CS cluster. More importantly the majority of new employment is full-time and comparatively well paid in a Wales manufacturing economic context. New employment created shares the relatively high productivity characteristics of existing employment in the sector, and with the profile of jobs being skilled whether at operative or technical, managerial and engineering grades.

EQ6: Increasing the skills base and/or alter the profile of skills in targeted regions?

In interviews undertaken to support this annual review it was clear that CS cluster members were unified in their aim to deepen the regional skills base. In part this comes through new employment opportunities, but also through training and development of existing staffs. Moreover, members of the CS cluster have been working with schools and further education colleges to encourage interest in the CS industry, and to encourage new applicants for CS sector roles from other industries in the region. For example encouraging retraining and skills development from those losing opportunities in the steel and transport sector. This, coupled with the growth of employment across the CS sector, reveals that the cluster is having a role in changing the profile of skills.

Figure 4.2 Future development factors : CS cluster in Wales

Regional Strengths of CS Cluster	Regional Opportunities in the CS cluster
Evidence of growth in GVA and employment in 2019-2021 Inward investment growth in sector Few parts of Welsh manufacturing have HQ type functions found in CS cluster High levels of R&D intensive activity and R&D staffs Relatively high earnings Relatively high productivity levels High export intensity CSconnected and developing front of house for the sector Value chain diversity in CS cluster	Building on the presence of HQ functions Strengthening collaboration with HEI sector in terms of testing, development and new CISM facility at Swansea CSconnected cluster recognised internationally and scope for greater inward investment Encouraging cluster firms to increase local purchasing propensity CIPD initiatives to improve labour supply side New inward investment in the sector Potential for spin out resulting from HEI-manufacturer collaboration Global CS market forecast to grow by 6-11%pa in period to 2025
Challenges for the CS cluster	**Issues for the CS cluster**
Much of the GVA impact focused on operation of a few members of the cluster Industrial exit could have negative spillover impacts on other parts of the CS cluster Limited opportunities to date to purchase goods and services in Wales	Wage inflation in the CS cluster Skills shortages in some key areas Increasing costs of energy and industrial gases Changes in patterns of consumer demand Changes in the structure and geography of the global semiconductor industry Trade tensions and tariff changes affecting sector exports Increasing global costs of wafer manufacturing

EQ7: Did funded-activities contribute to improved economic performance, particularly within targeted industries and regions?

This annual review has provided evidence of the performance of the CS cluster in terms of output, gross value added, employment and trade. Moreover, this performance can be linked to the wider industrial trends in the Welsh economy. The period 2019-2021 has been challenging for many parts of Welsh manufacturing including those which have traditionally added much to regional trade, output and employment such as the steel sector, and the transport equipment sector. There is emerging evidence here of the CS cluster becoming a more important player in the electronic and electrical engineering sector in Wales, and in the manufacturing sector as a whole.

EQ8: Did SIPF contribute to closing gaps in economic performance across UK regions?

Various analyses have been undertaken over the last two decades to explore the reasons why Wales falls behind other UK regions in terms of indicators such as gross value-added per head of the population. Research has explored factors that appear to contribute to the persistence of gaps with work examining industry structure (Webber et al., 2018), poor specialisation in growth sectors (Bryan et al. 2006), inward investment (McNabb and Munday, 2017), equity gaps (Kapitsinis et al., 2020) and skills deficits. Price and Jones (2021) conclude that: "Wales' poor comparative performance on GVA per head is mainly a reflection of relatively low productivity levels. Productivity, measured as GVA per hour worked continues to be lower in Wales than almost all other parts of the UK."

This report suggests that productivity levels in the CS cluster are relatively high compared to other parts Welsh manufacturing, and with much of this relating to the nature of the capital stock. It is accepted that more work will need to be undertaken in future years to explore productivity per hour worked in the CS cluster. This noted, a conclusion from the report would be that CS cluster growth would be a force improving Welsh productivity levels.

EQ15: To what extent does the SIPF represent value for money given the overall impact on knowledge, economy and society relative to the size of the investment?

In estimating the value for money around the £25m UKRI investment into CSconnected it will be necessary to establish counterfactuals i.e. the extent to which CS cluster growth would have occurred in the absence of the CSconnected initiative, and then with issues of displacement, leakage of impact outside of the targeted region etc. Without addressing these it is impossible to link CS cluster employment and gross value-added increases to the activities of CSconnected. Notwithstanding this annual review reveals something of the scale of activity with the CS cluster as a whole supporting an estimated £248m of GVA in Wales in 2021 which is around 10 times the amount of the UKRI SIPF investment.

4.3. Moving ahead to 2022-2023

Over the next year the team at Cardiff University will continue to develop the economic impact evidence base around the CS cluster. In particular, the development of case studies around the CSconnected programme is one means of examining aspects of CS cluster development which are less easily valued in monetary terms. In the next period better economic data relating to the performance of the sector in Wales from organisations such as the Office for National Statistics will be sought.

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