

The National Productivity Board

ANNUAL REPORT

2022

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1. Executive Summary

1. EXECUTIVE SUMMARY

The Malta Council for Economic and Social Development (MCESD) Act Article 8(b) stipulates that the National Productivity Board shall be tasked with ‘preparing an annual report outlining the main competitiveness and productivity challenges facing Malta, and the policy responses required to meet them and any recommendations thereto.’ In this regard, this report shall focus on the thematic area of research, development and innovation (RDI) which is a key driver of productivity and competitiveness.

As discussed in detail within this report, the Maltese economy has, on average, consistently lagged behind its European counterparts when it comes to RDI spending and participation. RDI can be broadly defined as efforts undertaken by private and public sector entities with the purpose of developing new methods of production (including the delivery of goods and services), or the creation of entirely new products. Within this report, a broader definition of RDI is followed, which includes the concepts of organizational innovation, market innovation as well as input innovation. Given the consensus regarding the importance of RDI for productivity, the focus of this report will be centred around developing a better understating of the key drivers and crucially, the key challenges surrounding the development of RDI activities in Malta and to subsequently provide policymakers with several recommendations intended to mitigate or overcome such challenges.

The recommendations put forward in this report must be assessed in light of the current economic scenario faced by the Maltese economy, and indeed the rest of the world. It should be noted that several positive economic developments were recorded over 2021, especially in terms of GDP growth and labour market developments. The Maltese economy’s recovery from 2020 was strong, such that pre-pandemic GDP levels were exceeded, recording real GDP growth of 10.3% at a time when the EU-27 average only grew by 5.3%.

The unemployment rate in 2021 fell to 3.5%, falling slightly below pre-pandemic levels, whilst at the same time, the EU-27 average recorded an unemployment rate of 7.0% over the same period. According to the macroeconomic forecast presented within the Ministry for Finance and Employment’s Draft Budgetary Plan 2023 published in October 2022, real GDP growth is anticipated to accelerate by a further 6.0% and unemployment is expected to decline to 3.1% over 2022. Notwithstanding these developments, there are still numerous economic challenges that the Maltese economy faces and that are leading to a high degree of uncertainty. The geopolitical conflict between Russia and Ukraine, the growing risks of stagflation, the supply-chain disruptions ensuing from the COVID-19 pandemic, and rising social instability represent a major headwind to global economic growth. Even though these disruptions are spread worldwide some factors may still hinge on the relative competitiveness of Malta. Indeed, Malta’s inflation rate as recorded by the Harmonised Index of Consumer Prices (HICP) has increased rapidly since the third quarter of 2021, rising from 0.3% to 7.4% as recorded in October 2022.

Given the underlying economic conditions, it was decided that in order to develop a deeper understanding of the facilitators and barriers to RDI in Malta a three-step approach was to be employed. The first step was to undertake an assessment of the

key indicators for productivity and innovation pertaining to the Maltese Economy and to highlight key characteristics which are important to contextualize in relation to the potential drivers and barriers. The next step was to synthesise the academic literature with a focus on highlighting several aspects of the RDI-productivity relationship that can be of particular relevance to the Maltese economy. This provided the background to develop an appropriate understanding of what RDI activities effectively consist of in today's ever-changing global environment and to also identify which are the established key drivers and challenges of RDI for which there is broad academic consensus. The insights gathered from these first two steps were crucial to then formulate and undertake a set of interviews and focus groups. At the core of the methodology employed a combination of methods were used for the collection of primary data, namely interviews and focus groups, in which we employed a variety of techniques and questioning styles depending on the information sought out. The information gathered enabled us to develop sector-specific insights that allowed for the identification of a set of ten recommendations aimed to spur on and facilitate RDI activities in the years ahead. An important aspect of the analysis undertaken is that it aims to provide a sectoral perspective on the current state of play with respect to RDI in Malta and to highlight which are the key enablers and barriers to RDI. To this end, eight overarching economic sectors were chosen based primarily on their relevance for RDI activities in the Maltese economy, together with the inclusion of Gozo as a separate sector. Including a separate section for Gozo was deemed important in order to appropriately account for Gozo's unique characteristics, challenges, and opportunities in this field.

This report had a cut-off date of 25th October 2022 and is structured as follows. [Chapter 2](#) provides an overview of the Maltese economy with a focus on the recent macroeconomic developments, both at a national as well as at a sectoral and regional level, with a focus also on the challenges surrounding the underlying Maltese macroeconomic environment both in the short-term and in the medium-term. [Chapter 3](#) puts forward a detailed comparative

analysis of the key drivers of competitiveness, productivity, and RDI in Malta. [Chapter 4](#) provides a survey of the literature on the drivers of RDI with a focus on the Maltese Economy which also highlights the relevance and importance of SMEs within the context of driving RDI forward. [Chapter 5](#) presents an overview of the methodology employed to identify the recommendations put forward in this report. [Chapter 6](#) presents the key findings obtained from the primary data gathered via the interviews and focus groups aimed at assessing the research, development, and innovation landscape within the Maltese Islands from a sectoral perspective. [Chapter 7](#) then presents a list of recommendations emanating from the analysis carried out in this report, as well as an assessment of the progress on the National Productivity Board's past recommendations relating to the thematic area of RDI. [Chapter 8](#) presents the report's concluding remarks.

2. Economic Context

2. ECONOMIC CONTEXT

This section firstly presents an economic analysis of Malta's performance over the past few years, whilst taking a macroeconomic approach with a focus on the main indicators, this section also gives a detailed analysis of the impact of COVID-19 on Malta's economic performance. Secondly, a detailed analysis of Malta's productivity and competitiveness follows with a focus on both the local context as well as by benchmarking Malta's performance on a regional level. Finally, this section also highlights several pressing economic challenges.

2.1 Macroeconomic trends

Malta's economic performance has been sustained by several years of strong economic growth. Indeed, in the period 2011 - 2019 (pre-pandemic), Malta's real Gross Domestic Product (GDP) growth averaged 6.0% as opposed to an average growth rate of 1.5%

for the EU27. Real GDP Growth in Malta peaked at 10.9% in 2017, before gradually decreasing to 5.9% in 2019 (see Figure 2.1), still significantly above the EU27 average growth rate of 1.8% in 2019. As a consequence of the COVID-19 pandemic, the Maltese economy contracted by 8.3% in 2020, slightly

Figure 2.1: Real GDP in levels and growth rate



Source: NSO, Eurostat

higher than the EU27 average of 5.7%. Over the last decade the growth in the export-oriented services, driven primarily by the expansion of the Tourism, Finance, IGaming, and Aviation sectors, has been an important factor which has underpinned the exceptional economic growth generated throughout this period. The Maltese economy's subsequent recovery in 2021 was strong, such that pre-pandemic GDP levels were exceeded, recording real GDP growth of 10.3%. At the same time, the EU27 average grew by 5.3% which falls short of recovering to pre-pandemic levels.

In the years leading to the pandemic, Malta's domestic demand had also become an important contributor to GDP growth in Malta, mainly driven by growth in private consumption (See Figure 2.2). Indeed, the robust growth in employment and the higher disposable income available to Maltese households contributed to an improved economic sentiment which led to higher private spending. Another contributing factor to private consumption growth was the increase in the population as a result of the

influx of non-Maltese nationals, increasing the domestic market. In 2020, both the domestic side of the economy and net exports contributed to the contraction in total economic growth. In fact, only government consumption grew that year as a result of the COVID-19 measures implemented during that year. The economic recovery from the pandemic in 2021 was mainly led by the recovery in private consumption and investment together with a positive contribution from external demand.

During this past decade, Malta's real Gross Value Added (GVA) was mainly driven by 'professional, scientific and technical activities', 'information and communication activities' and 'wholesale and retail trade, transport, accommodation and food services activities' (see Figure 2.3). During the pandemic, gross value added contracted by 7.3% which was mostly attributed to the negative impact on the 'wholesale and retail trade, transport, accommodation and food services activities' which contributed around 7.1pp (percentage points) of the negative growth in real GVA. It is important to note that in 2020, the GVA of

Figure 2.2: Nominal GDP and its components



Source: NSO

‘information and communication activities’, ‘financial and insurance activities’ and the ‘arts, entertainment and recreation activities’, which include the IGaming sector still grew and contributed positively to GVA. Indeed, the resilience of these sectors played a key role in mitigating in part, the negative impact of the pandemic on the Maltese economy. In 2021 all sectors contributed positively to real GVA growth which exceeded pre-pandemic levels. Having said that, travel-related sectors, particularly the ‘wholesale and retail trade, transport, accommodation and food services activities’ sector was still below pre-pandemic levels in 2021.

Given that Malta is an open economy it relies heavily on international trade, which in turn is an important contributor both to the general economic performance and employment. Figure 2.4 shows the developments in the main components of Malta’s current account within the Balance of Payments (BoP). Prior to 2020, Malta was recording current account surpluses mainly on the back of fast-growing industries including the tourism and gaming sectors. Even

though the services sector remained in a positive trade balance during the pandemic it was offset by the negative trade balance in the goods market and primary and secondary income. More recently, the recovery in the services sector led to an improvement in its trade balance however this has been mostly outweighed by the increasingly negative trade balance in the goods market, mainly as consequence of the conflict between Russia and Ukraine. This has resulted in supply chain disruptions and increases in world prices.

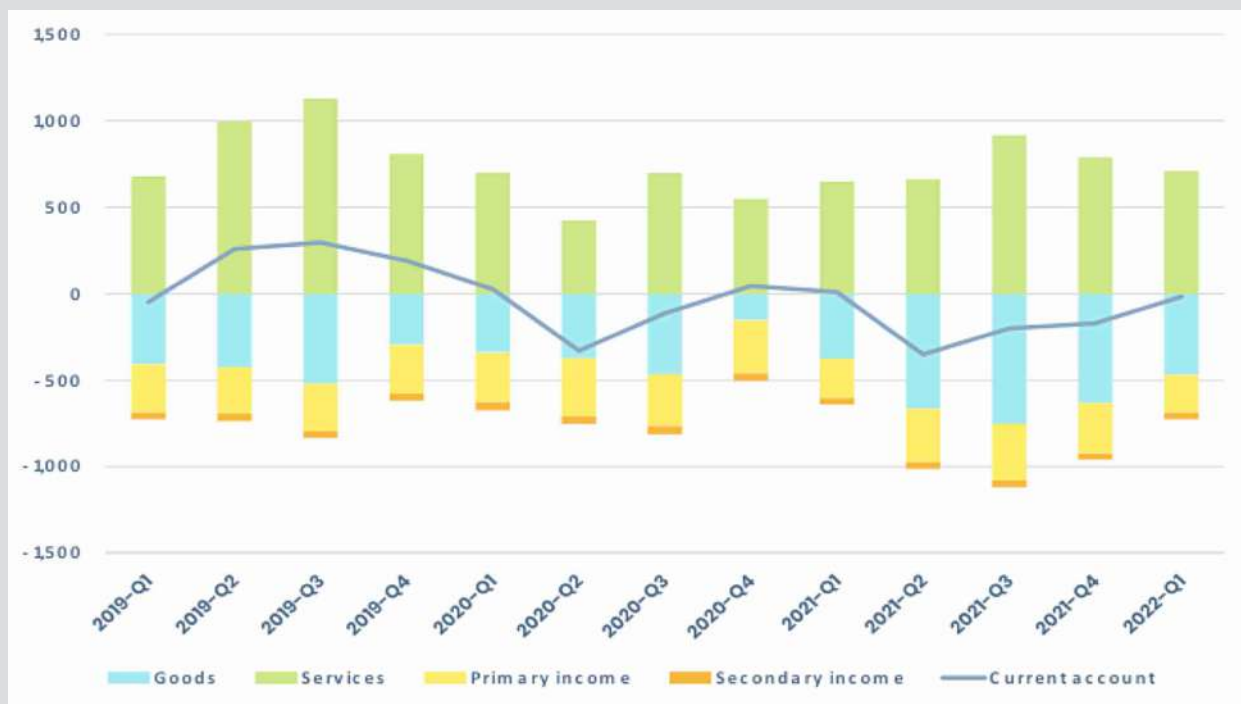
Malta’s economic performance in recent years is also reflected in its employment rate figures. Indeed, employment rates have outperformed the EU27 average since 2014. Malta’s employment rate in 2021 stood at 78.6% whilst the EU27 employment rate was at 73.1% (see Figure 2.5). This represents an 18.5pp increase since 2010, the result of a set of effective labour market policies introduced in 2014 which encouraged women to join the labour force by providing free childcare services and other active labour market policies. In addition, significant

Figure 2.3: Contribution to real gross value added by sector



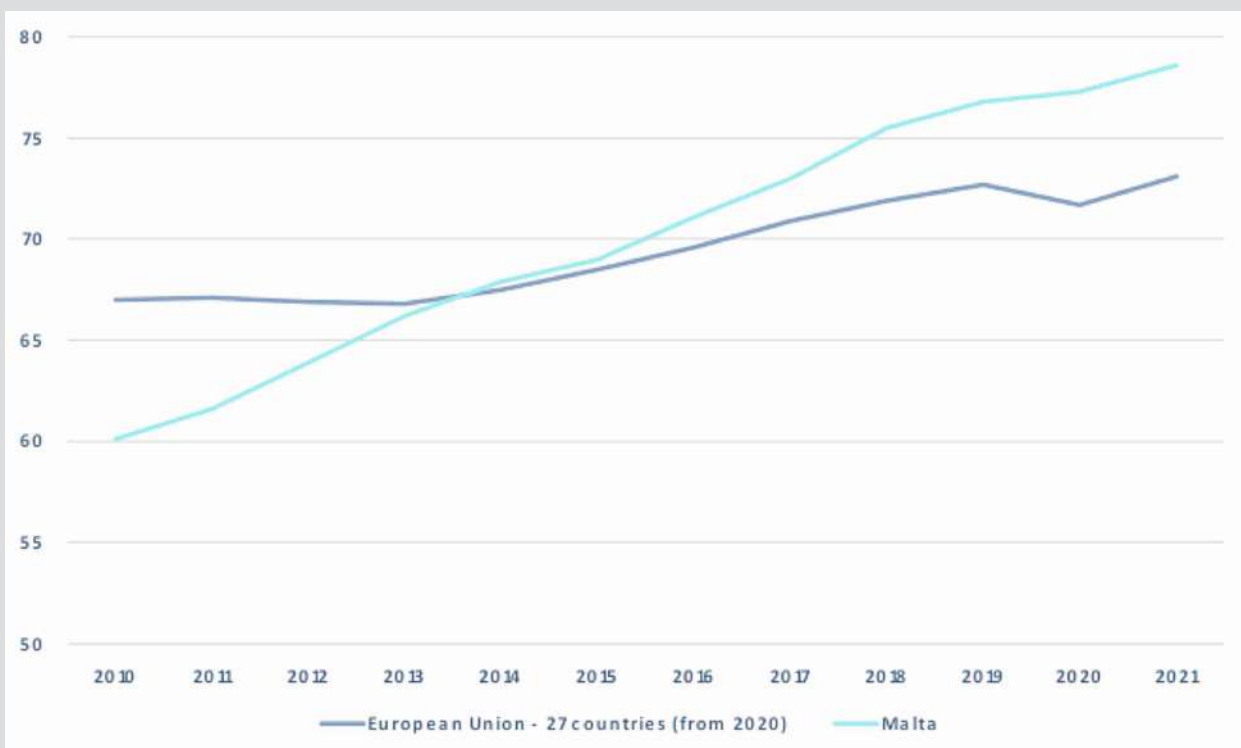
Source: NSO

Figure 2.4: Current account balance and components



Source: NSO

Figure 2.5: Employment growth (%)



Source: NSO

increases were also evident in older workers remaining in employment past retirement. At the same time, the Maltese labour market had a significant boost from the influx of foreign workers. Indeed, as of April 2022, foreign employees accounted for 29.5% of full-time and part-time employees.

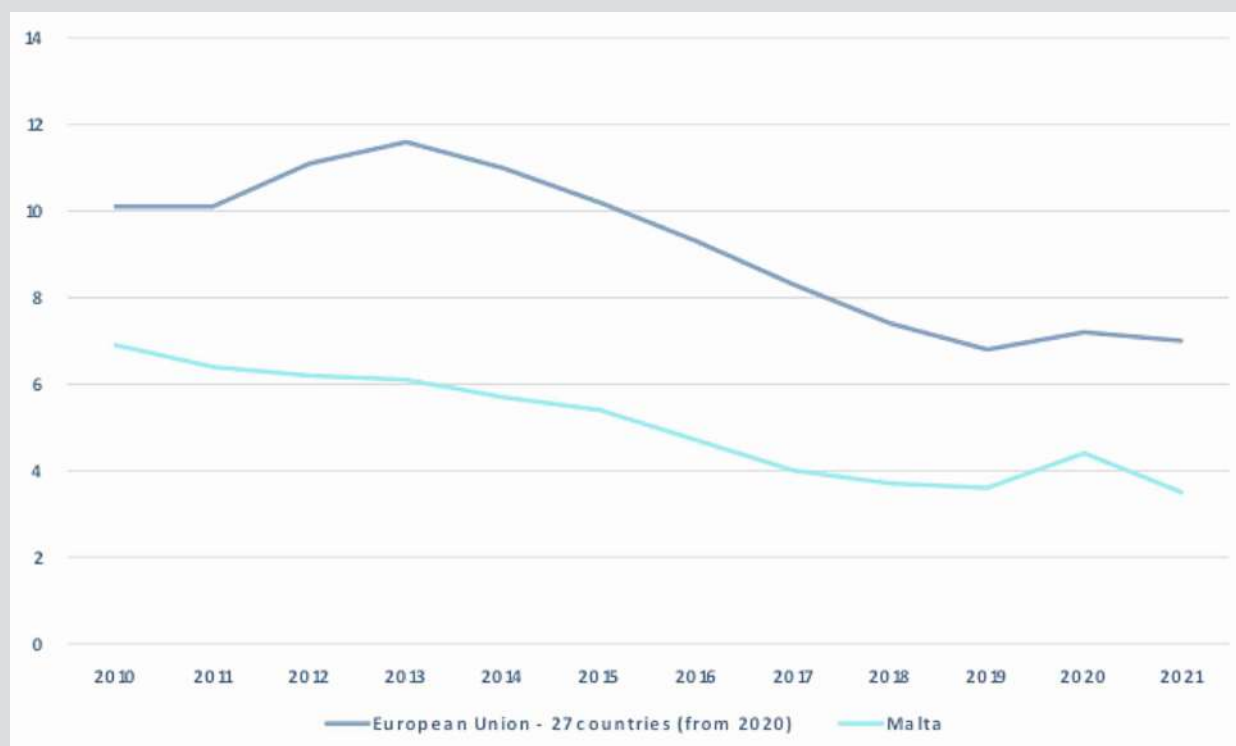
While employment increased, unemployment was on a downward trend, only increasing slightly during the pandemic (see Figure 2.6). Malta's unemployment rate has consistently been significantly lower when compared to the EU27 average. The labour force survey shows that during the past decade, Malta halved its unemployment rate from 6.9% in 2010 to 3.6% in 2019, increasing marginally in 2020 to 4.4% which then fell lower than pre-pandemic in 2021 to 3.5% (see Figure 2.7). At the same time, the EU27 average recorded an unemployment rate of 7.0% in 2021.

Fiscal sustainability is a key component for macroeconomic stability and long-run growth

prospects. In recent years, the government has been building a healthy fiscal buffer, reaching its medium-term budgetary objective in 2016 and registering consecutive surpluses up to 2019. The fiscal space created by these surplus years was useful at times of crisis created by the pandemic and the subsequent conflict between Russia and Ukraine. Through several budgetary measures, the government managed to safeguard employment and helped soften the impact of both the pandemic and the war in Ukraine. As a result of these measures, the budget balance has swung back into a significant budget deficit¹. It is positive to note however that Malta's deficit has been reduced in 2021 and the recent forecasts published during the budget, the government plans to keep on reducing the budget deficit to reach -2.8% by 2025.

In terms of government debt, as show in Figure 2.8, since 2015 Malta has been in line with the fiscal rule of a debt-to-GDP ratio below 60.0% debt to-GDP.

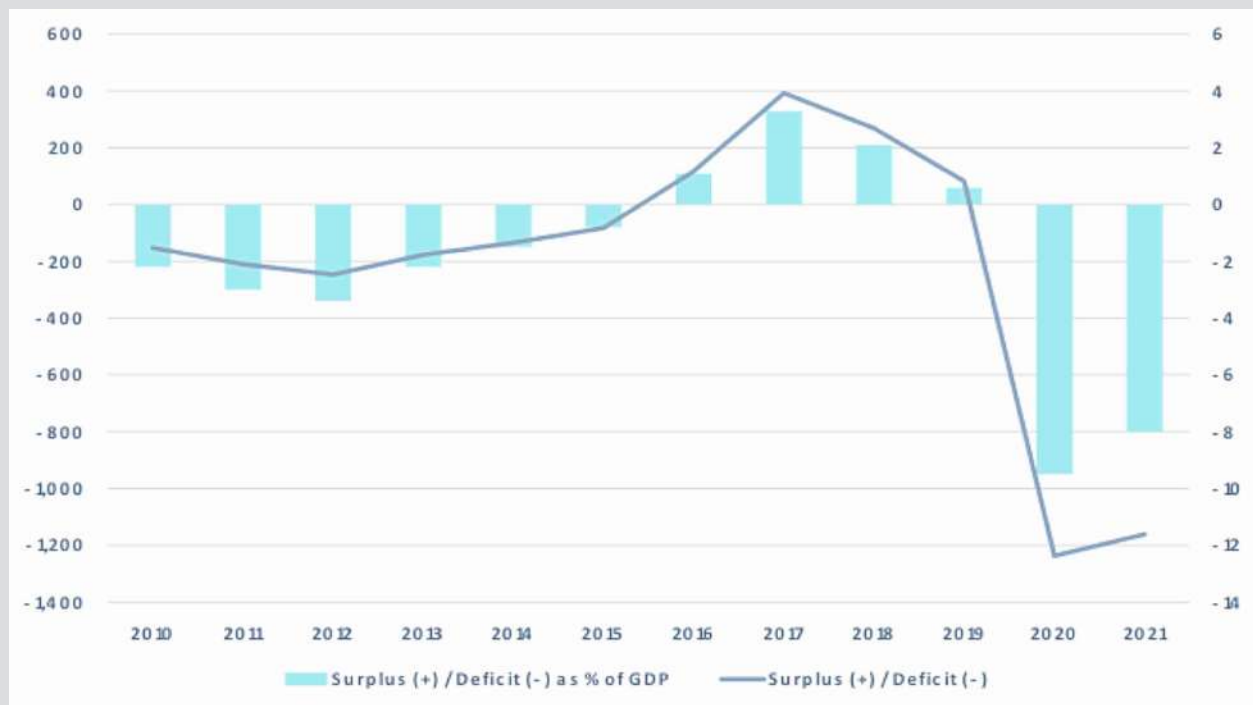
Figure 2.6: Unemployment rate (%)



Source: NSO

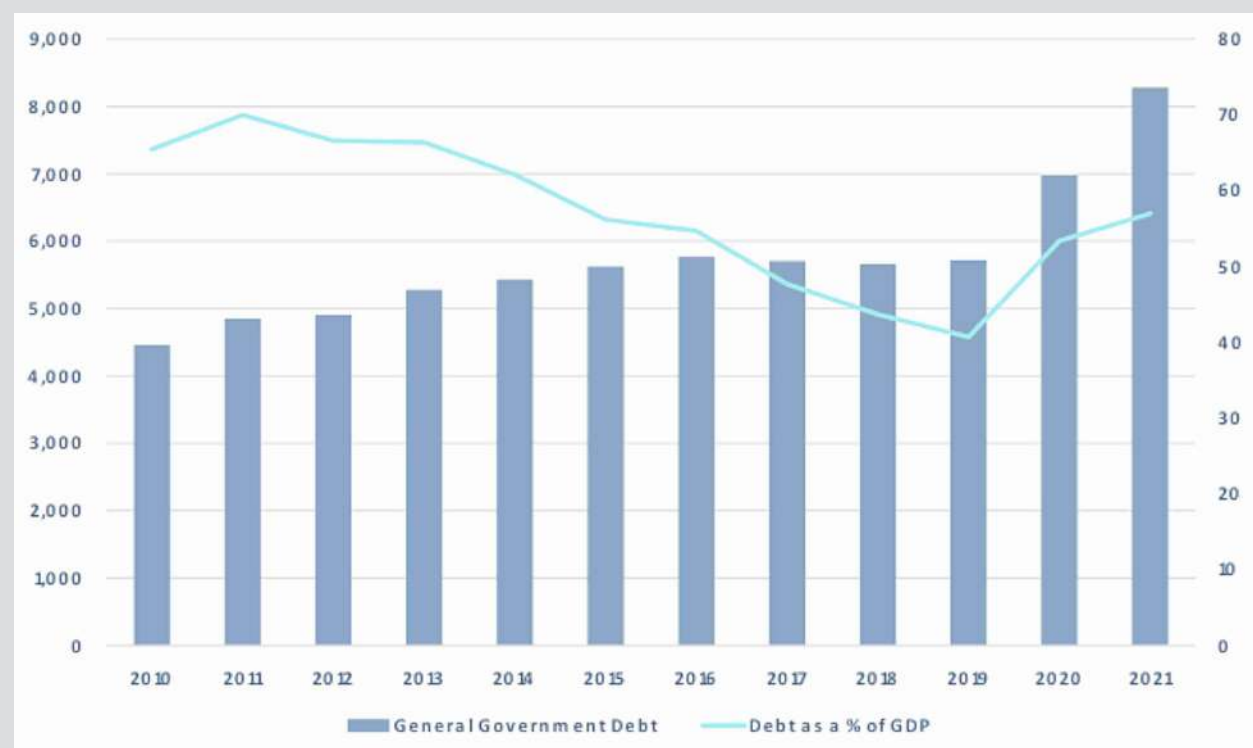
¹ In March 2020, the European Commission activated the general escape clause within the Stability and Growth Pact, effectively suspending the Maastricht Criteria requirements.

Figure 2.7: Deficit to GDP ratio



Source: NSO

Figure 2.8: Debt to GDP



Source: NSO

In fact, Malta's debt-to-GDP ratio continued to fall, reaching 40.7%, in 2019. Nonetheless, once again as a result of the pandemic and the war in Ukraine, this ratio has increased to 53.4% in 2020 and 57.0% in 2021. It is worth noting however that this level of debt is still in line with the fiscal rules and in the recent budget forecasts the government plans to keep this ratio near the 60.0% threshold.

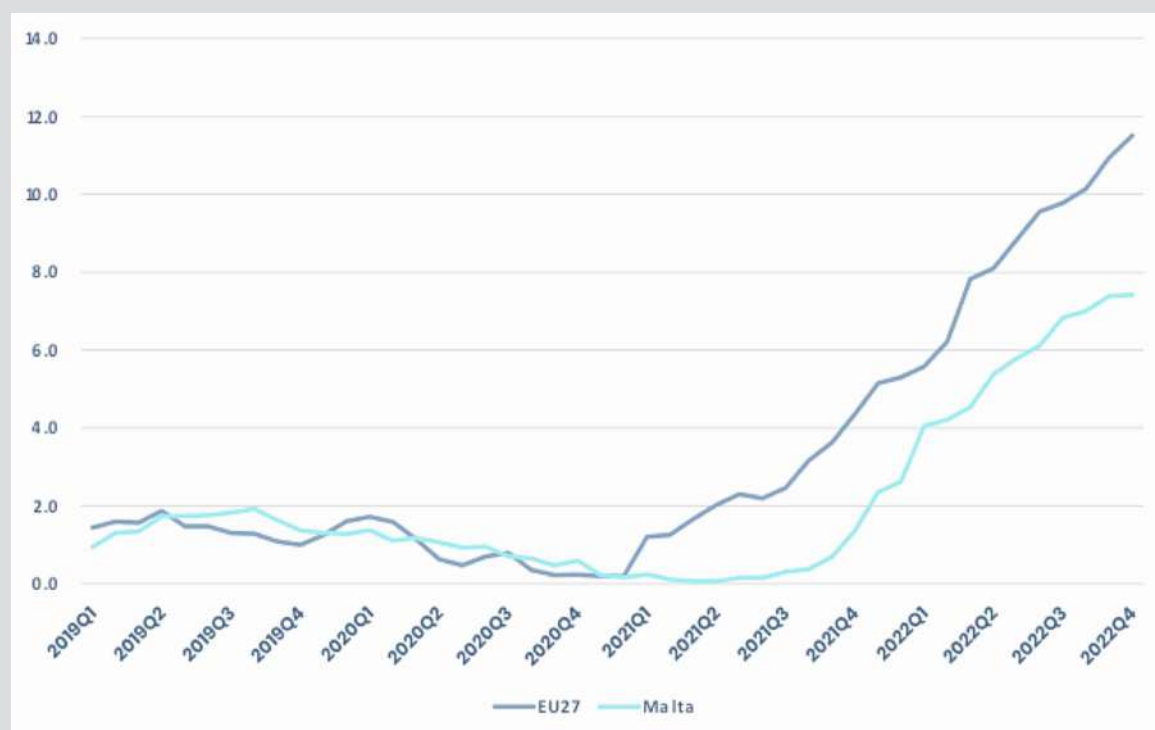
Malta's structural economic performance has been robust and broad-based. The strong economic growth

that was registered, together with its convergence to EU27 averages, had a positive impact on employment trends and unemployment rates. This strong performance was felt across other macroeconomic indicators including balance of payments and public finances. COVID-19 and its ensuing negative economic impact together with the negative global implications of the war in Ukraine have dented Malta's growth and remain a key challenge in the short-to-medium term (see Box A).

Box A: Implications of COVID-19 and the war in Ukraine

The geopolitical conflict between Russia and Ukraine, the growing risks of stagflation, the supply-chain disruptions ensuing from the COVID-19 pandemic and rising social instability represent a major headwind to global economic growth. Even though these disruptions are spread worldwide some factors may still hinge on the relative competitiveness of Malta. Indeed, Malta's inflation rate as recorded by the Harmonised Index of Consumer Prices has increased rapidly from the third quarter of 2021, rising from 0.3% to 7.4% as recorded in October 2022 (See Figure 2.9). This increase in inflation was however more strongly recorded for the EU27 average which by October of the same year had recorded an inflation rate of 11.5%.

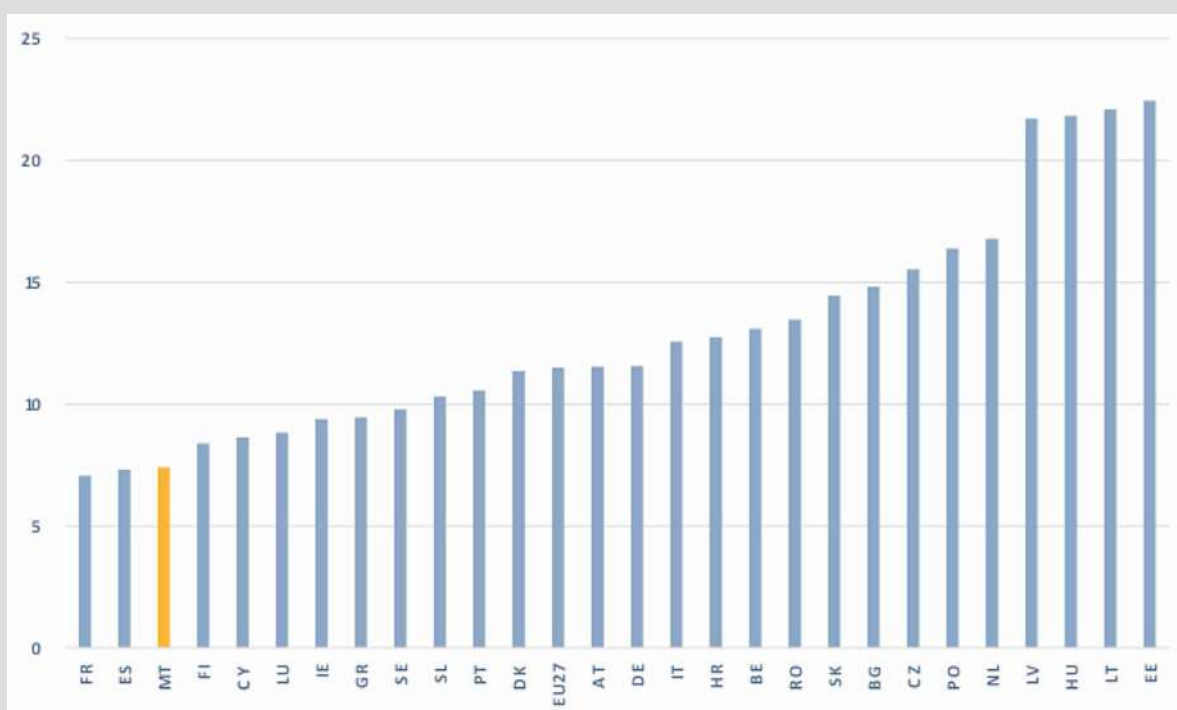
Figure 2.9: Harmonised index of consumer prices - October 2022



Source: NSO, European Commission

It is interesting to note that Malta's inflation rate when compared to that of the EU27 countries is only the third lowest, with only France and Spain recording slightly lower inflation rates during the same period (see Figure 2.10). Indeed, the highest inflation rates were recorded by Latvia, Hungary, Lithuania, and Estonia, averaging around 22.0%.

Figure 2.10: Harmonised index of consumer prices

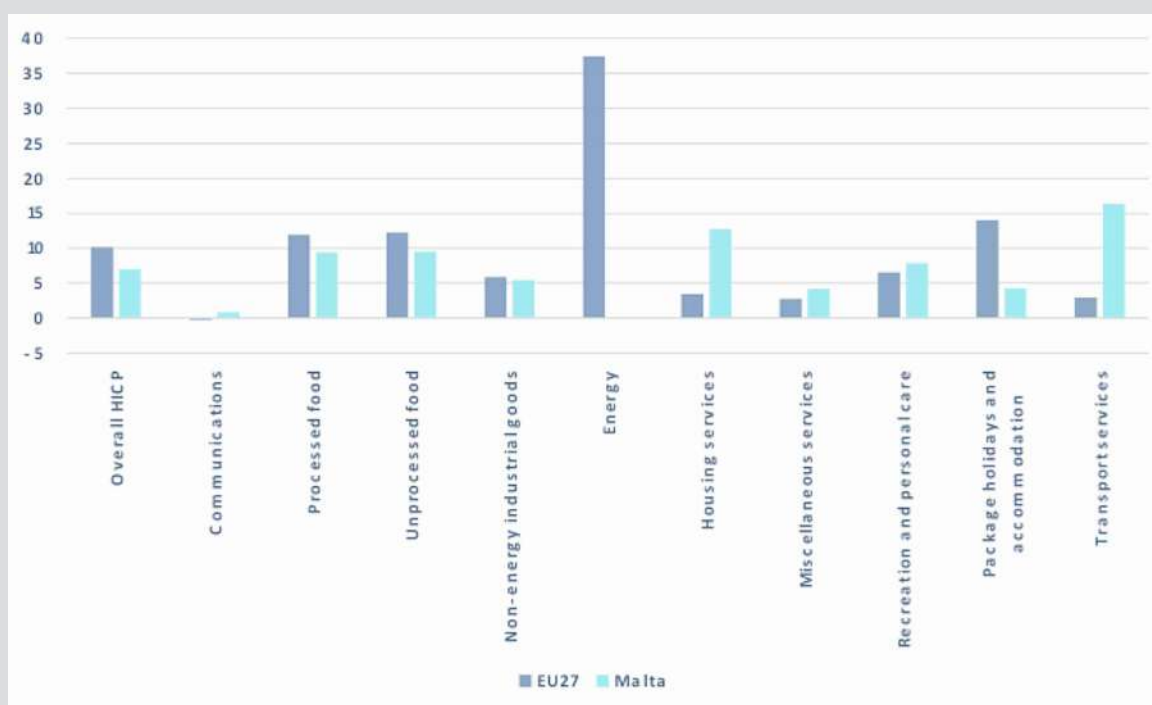


Source: NSO

Looking deeper into each individual component making up the HICP inflation measure, the highest recorded inflation in Malta was by 'transport services' whose price increased by 16.4% compared to a year earlier (see Figure 2.11). Significant increases in prices were recorded in most of the other components making up HICP, including 'housing services' (12.8%), 'processed food' (9.4%), 'unprocessed food' (9.6%), 'recreation and personal care' (7.9%), 'non-energy industrial goods' (5.4%), 'package holidays and accommodation' (4.3%) and 'miscellaneous services' (4.2%). The lowest inflation rate was recorded in 'communications' whose price grew by only 0.9%.

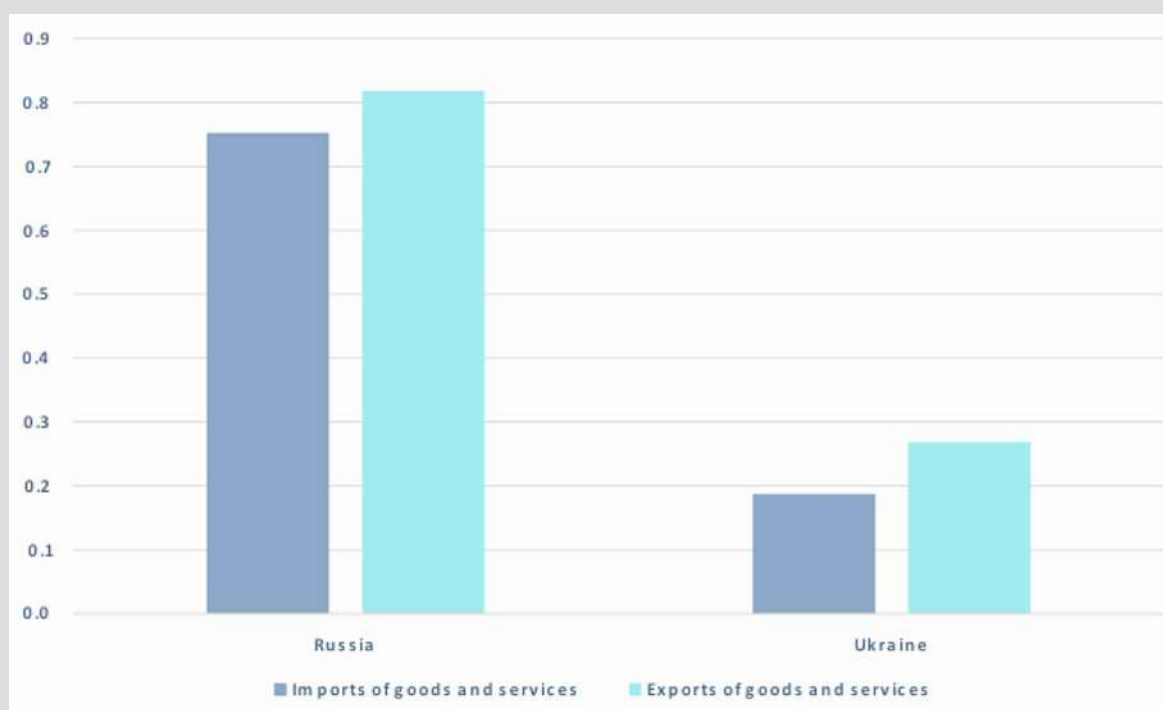
On the other hand, inflation on 'energy' in Malta registered no growth in prices which is all attributable to the energy support measures initiated by the government to keep energy prices stable for households and businesses in Malta. In contrast, this component recorded the highest inflation rate amongst the EU27 countries at 37.5%. Malta's energy mix is made up of imports of oil and petroleum products and imports of natural gas. More than 80.0% of energy imports in Malta are petroleum products. Russia was the fourth largest importer of petroleum products in 2020 accounting for around 8.2% of total imports for this product in Malta. On the other hand, imports of petroleum products from Ukraine were minimal amounting to 0.2% of total imports for this product. In the importation of natural gas, Malta has no trade agreements on gas with Russia, unlike various other European countries which combined have around 40% of their natural gas imported from Russia.

Figure 2.11: HICP by component EU27 and Malta, difference



Source: NSO

Figure 2.12: Trade with Russia and Ukraine as a share of total trade (%)



Source: NSO

Malta is also connected with both Russia and Ukraine through other trades of goods and services is (see Figure 2.12), being a net importer in both countries. The ratio of imports of goods and services from Russia and Ukraine in 2020 and 2021 had already fallen substantially (mostly due to COVID-19 and supply constraints). In 2020 the share of imports and exports of goods and services from Russia was only 0.75% and 0.82% respectively, while for Ukraine the share was 0.19% and 0.27%, respectively (see Figure 2.14). Supply constraints have led to a substantial increase in the prices of goods, especially those goods imported exclusively from Russia and Ukraine. These mainly relate to food-related items such as wheat, grain, and animal fodder. The government is also providing support on commodity prices and supply security measures to keep food price increases controlled.

Tourism is a key sector in the Maltese economy and contributes to a large part of Malta's economic growth. During the COVID-19 pandemic, Malta's tourism sector took a downfall, but Malta has since recovered around 80% of pre-pandemic inbound tourist levels. Russia and Ukraine do not form an integral part of the tourism sector of Malta (see Figure 2.13) but nonetheless, it should be noted that inbound tourists from Russia and Ukraine have all fallen to record low levels in recent years.

Figure 2.13: Russian and Ukrainian inbound tourists as a percentage of total inbound tourists



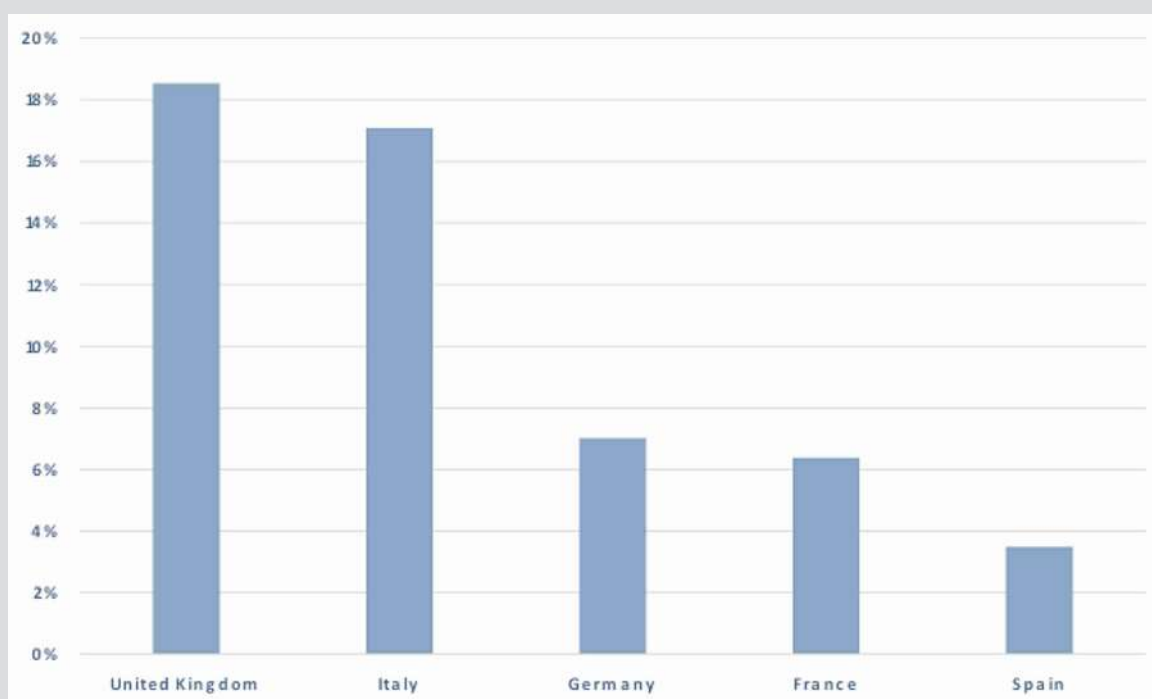
Source: NSO

In general, the negative direct effects emanating from the Russia-Ukraine war on the Maltese economy are minimal. Indeed, the European Commission had published a vulnerability matrix that shows that Malta is the least exposed across all the European economies. This due to the low exposure to Russian energy and low exposure to Russian assets². Malta is only seen to be somewhat exposed to direct services exports to Russia, Ukraine, and Belarus, through 'professional business services'.

² Available at https://ec.europa.eu/info/sites/default/files/economy-finance/ecfin_forecast_spring_2022_box-i-2-2_en.pdf

Nonetheless, Malta is also connected to Russia and Ukraine indirectly through its main trading partners. Malta's main trading partners are the United Kingdom, Italy, Germany, France, and Spain which in total amount to more than half of Malta's total imports (See Figure 2.14). Thus, the health of the economies of Malta's main trading partners is of great importance. Indeed, these countries all experienced an increase in their inflation rates although they are not the worst impacted among the EU27 countries (See Figure 2.15).

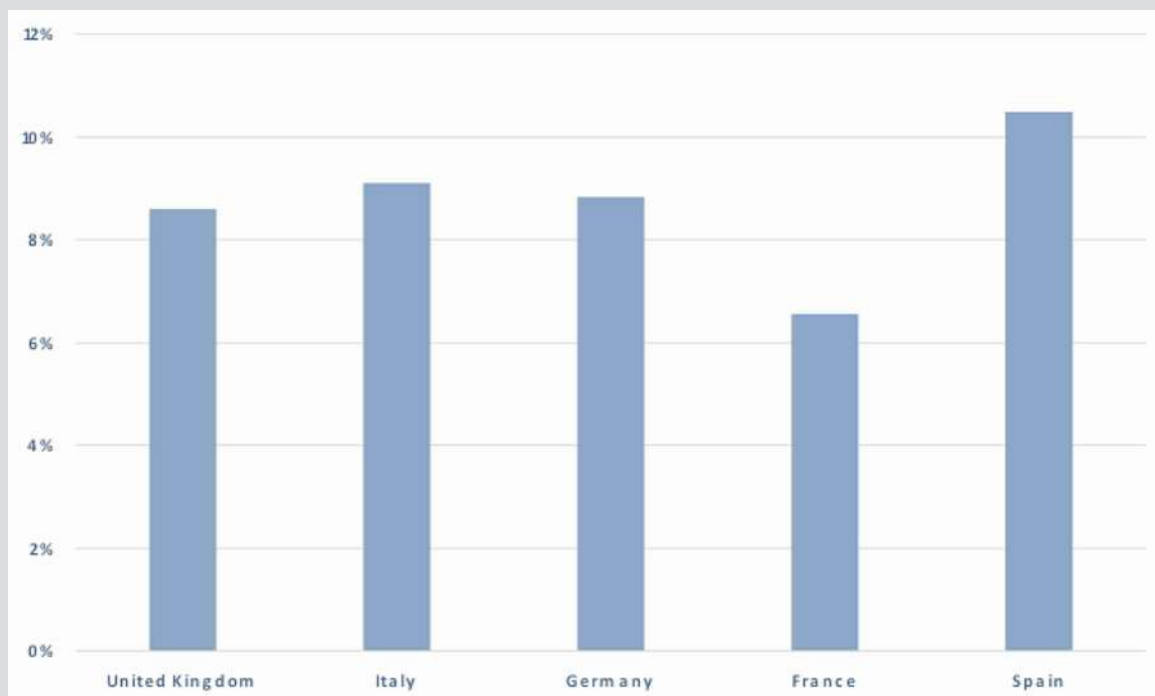
Figure 2.14: Share of imports from Malta's main trading partners - 2019



Source: NSO

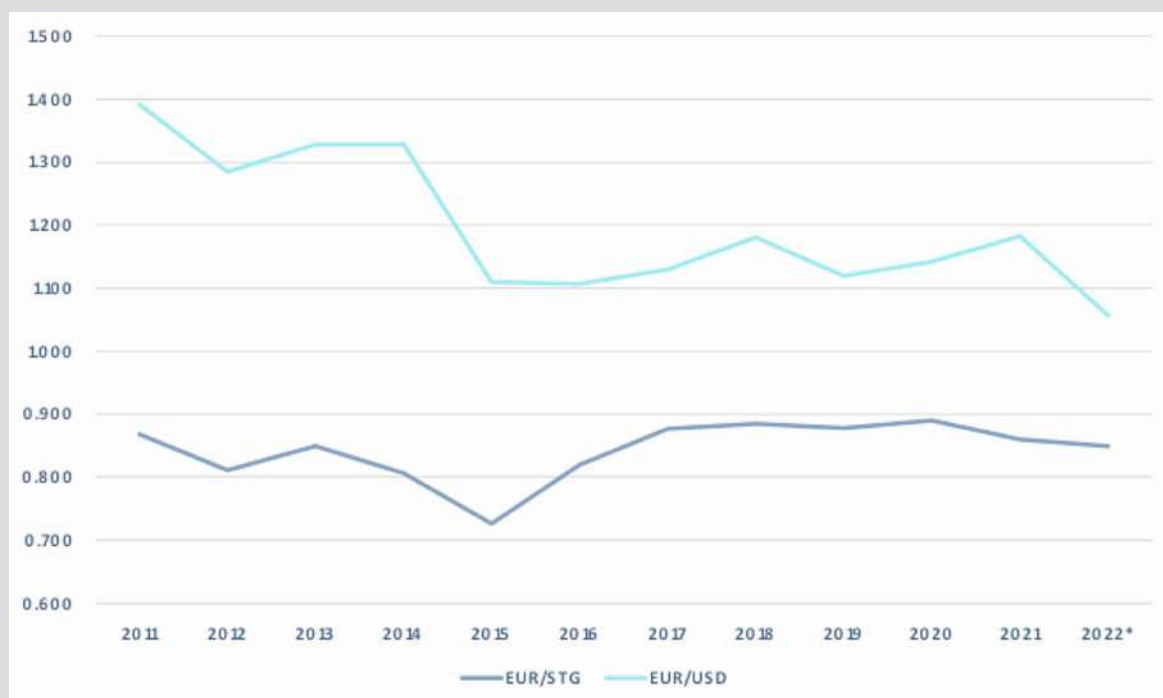
In addition to the indirect effects, the euro's value has an impact on both the inflation rate and on growth in an economy. In recent months both the Euro/USD and the Euro/STG exchange rates have depreciated when compared to their historical averages (see Figure 2.16). If the conflict continues, and uncertainty remains investors are expecting the euro to keep trading at low prices.

Figure 2.15: Inflation rates of Malta's main trading partners - October 2022



Source: NSO

Figure 2.16: EUR/USD and EUR/STG exchange rates



Source: European Commission

2.4 Regional economic context

In 2020, the GDP in the regions of Malta and Gozo and Comino was estimated at €11,326.6 and €506.9 million respectively corresponding to 90.2% and 4.0% of national GDP (see Figure 2.17). Both Malta and Gozo and Comino have followed a similar growth pattern across these past years. We note however that in the two years pre-pandemic Gozo and Comino's GDP was increasing at slightly faster rates.

Looking at the regional sectoral shares of the nation's GVA (see Figure 2.18), we note that most of Gozo and Comino's gross domestic product is derived from agriculture forestry and fishing, followed by construction and real estate activities. The other sector's contribution is minimal mostly when it comes to services-based sectors such as the information and communication, financial and insurance and arts and entertainment sectors. Indeed, Malta's contribution is higher compared to Gozo and Comino in all sectors given its larger population.

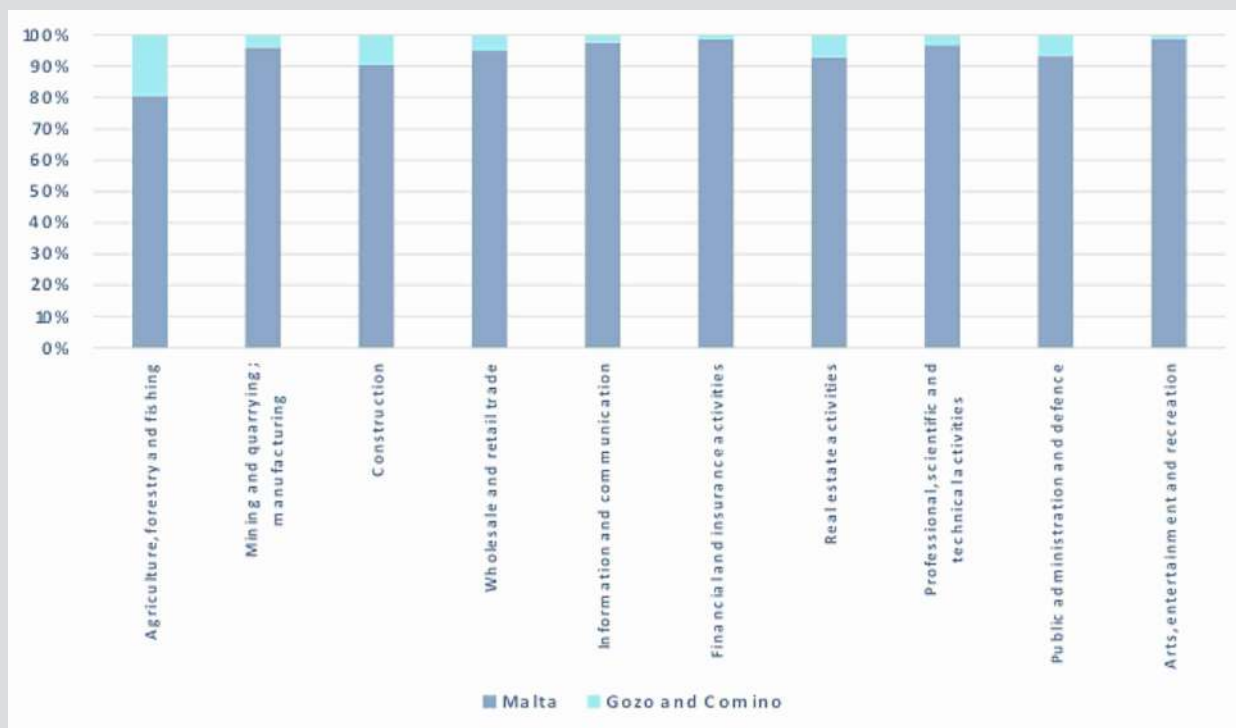
During 2020, GDP per capita decreased in both regions (see Figure 2.19). The per capita GDP at market prices for the Malta region as a percentage of the national was 102.5% while that of Gozo and Comino region stood at 63.9%. At the same time, population growth also fell for both regions in 2020, following years of growth.

Figure 2.17: Gross domestic product for Malta and Gozo



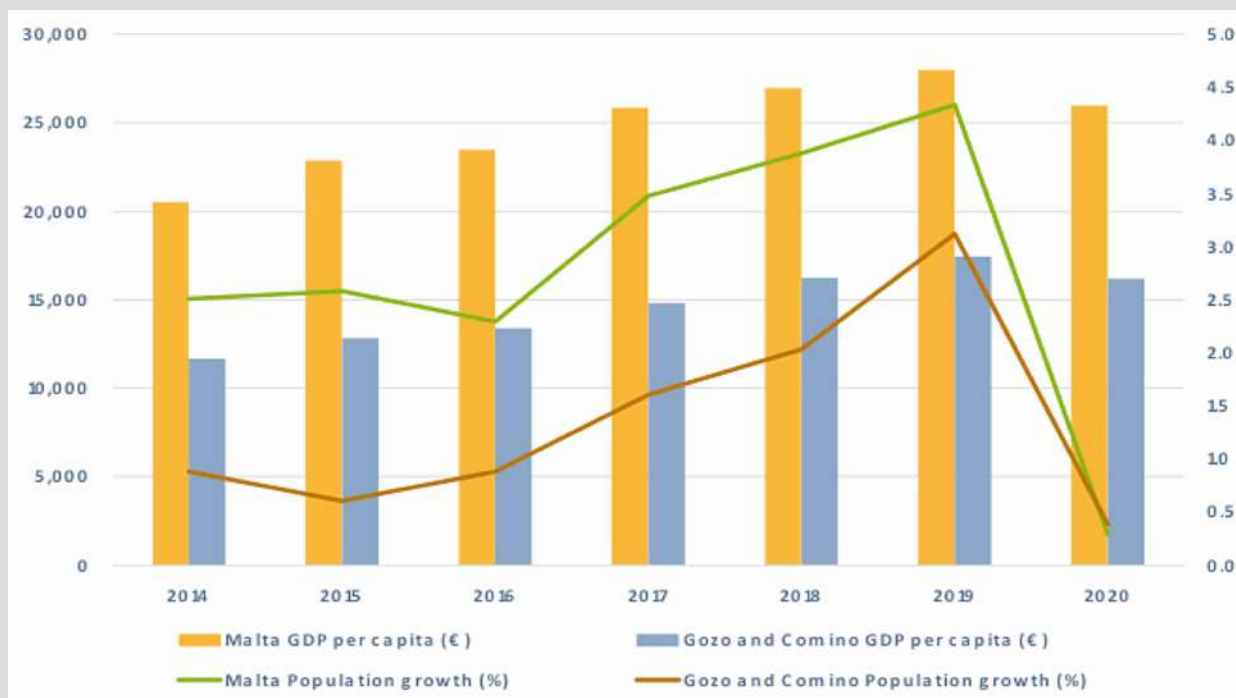
Source: NSO

Figure 2.18: Regional sectoral shares in Gross Domestic Product



Source: NSO

Figure 2.19: Per capital gross domestic product and population growth



Source: NSO

Figure 2.20: Sectoral GDP growth vs employment growth for Gozo - 2020



Source: NSO

In 2020, almost all the industries registered employment growth in Gozo and Comino region (see Figure 2.20). Real estate activities (-2.7%) and mining and quarrying activities (-3.5%) were the only activities that registered negative employment growth during the year. At the same time, employment in mining and quarrying also fell in the region of Malta, however, employment within real estate activities grew by 3.2%. It is interesting to note the high degree of difference in the employment growth of the information and communication sector, the professional, scientific and technical sector and the arts, entertainment and recreation sector which saw higher increases in the region of Gozo and Comino. This may suggest that these sectors within Gozo and Comino are still below full employment and that there are still some productivity gains to be made.

2.5 Malta's economic challenges and prospects

2.5.4 Short-term economic challenges

The most pressing short-term challenge in the Maltese economy are those which are present as a result of some of the prevailing issues which emanated from the COVID-19 pandemic and the subsequent crisis which erupted as a consequence of the war in Ukraine. Indeed, the COVID-19 pandemic had already created an issue in international trade with [supply chain disruptions](#) led by the high demand during the pandemic, already increasing world oil prices and a shortage of workers within the cargo transportation sector. Concomitantly, the war between Russia and Ukraine erupted which resulted in major sanctioning of Russia globally. This led to further shortages which erupted prices globally leading to a high level

of inflation worldwide. These disruptions are indeed impacting the supply side of the economy, leaving a negative impact on global industrial production and trade and in turn dampening global economic growth.

The government of Malta had subsequently committed to subsidising [energy-related price increases and to some extent the increases in food prices](#). Indeed, without these measures, according to a study carried out by the Ministry for Finance in its pre-budget 2023 document the GDP would have fallen by 2.3pp, while inflation as recorded by the HICP would have been 7.1pp higher. At the same time from the same study, the Ministry indicates that both real disposable income and profits would have fallen by 1.6pp and 2.1pp, respectively. While investment would have fallen by 1.1pp. Nonetheless, even though these measures have aided the macroeconomic side of the economy, the fiscal side has suffered with increasing debt levels although the debt-to-GDP ratio is still below 60%, and the budget balance turning from surplus to a relatively high deficit. The challenge here is to maintain fiscal sustainability while at the same time maintaining a solid economy with healthy economic activity.

2.5.5 Medium to long-term economic challenges

Once the Russia-Ukraine war is muted down and prices start to stabilise it is important that Malta starts rebuilding its [fiscal space](#). This is important to create a fiscal buffer which can be used in times of crises. This was evident at the time of the pandemic as Malta had previously recorded back-to-back fiscal surpluses this could then be used to create measures to stimulate and aid the economy in times of need.

Another issue is related to the efforts being made for [tax harmonisation](#) across the EU member states. Although difficult to determine the net effect and magnitude that, a system of tax harmonisation within the EU, would have on the Maltese Economy, it is likely that such a change could potentially reduce the attractiveness of Malta for international investors wanting to undertake foreign direct investment. Notwithstanding, Malta still is attractive for foreign investors for various other reasons as it is not solely

tax driven. Indeed, there are various other factors that have contributed to the generation of such business activities. These include regulation, a pool of professionals who are able to give a personalised service to their clients, the euro currency, economic stability, as well as less bureaucracy in the way business is established. Over the course of time, different areas of specialization where the country has clearly taken a lead. Examples here include the gaming and maritime sectors.

In addition, Malta faces some [demographic challenges](#) which unless addressed will impact productivity and the country's potential growth. Indeed, Malta has been experiencing lower fertility rates while also experiencing an ageing population. A positive development is that in recent years the influx of foreign workers has helped improve the dependency ratio and helped ease the dependency pressures on the local labour market.

The EU has committed itself to a [clean energy transition](#), which will contribute to fulfilling the goals of the Paris Agreement on climate change. To deliver on this commitment, the EU has set binding climate and energy targets for 2030: reducing greenhouse gas emissions by at least 40%, increasing energy efficiency by at least 32.5%, increasing the share of renewable energy to at least 32% of EU energy use and guaranteeing at least 15% electricity inter-connection levels between neighbouring member states. This undoubtedly creates new costs for the Maltese economy; however, the benefits outweigh the costs. The importance of mitigating the impacts of climate change in Malta is not only through the direct effects such as the negative impact climate change could have on sectors including tourism and agriculture but also through indirect effects. Indeed, the indirect effects could be brought about by food shortages as a result of changes in temperature, precipitation and soil moisture, increased refugee migration and further supply-side shocks.

3. RDI and productivity indicators for Malta

3. RDI and productivity indicators for Malta

The first part of this section presents an analysis of Malta's gross domestic expenditure on research and development (GERD). This is followed by the analysis of recent trends in Malta's innovation performance, as captured by a variety of indicators. The analysis then focuses on sectoral performance in relation to innovative activities within Malta as captured by the 2018 wave of the EU's Community Innovation Survey (CIS). The focus is then turned to provide a detailed comparison of the economic characteristics of the key sectors in the Maltese economy, with a focus on productivity performance as it relates to competitiveness. The section is rounded off by analysing the extent to which business expenditure on R&D is correlated with innovation, and the extent of productivity within each sector of the Maltese economy.

3.1 Measures of research and development

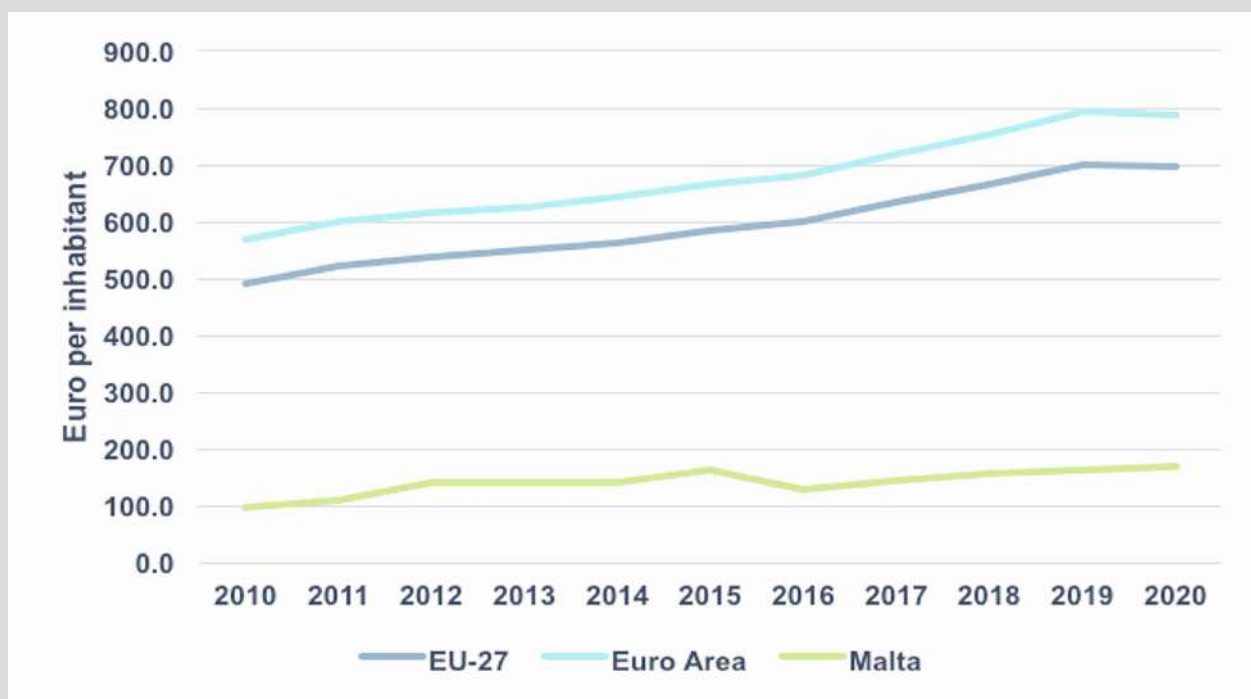
3.1.1 Gross Domestic Expenditure on R&D

We begin by looking at the gross domestic expenditure on research and development (GERD), which captures total annual spending on R&D within Malta across all sectors. Aggregate GERD expressed in per capita terms over the period 2010 to 2020 is shown in [Figure 3.1](#). As seen below, in 2020 Malta's GERD reached €169.40 per inhabitant, which is several orders of magnitude below the average GERD in both the EU-27 and Euro Area in 2020, which stood at €695.60 and €785.50 per inhabitant respectively. This shortfall is even more stark when comparing Malta's GERD to the EU-14 countries (EU-15 excluding the UK), which represent the higher-income countries within the EU, shown in [Figure 3.2a](#). As seen below, Malta recorded the lowest level of GERD spending per capita in 2020 relative to this cohort, with even the second-lowest level of GERD spending (by Greece) being 40% higher than Malta's level. Indeed, [Figure 3.2b](#) shows Malta's GERD spending relative to the new EU entrants,

consisting of countries with significantly lower levels of GDP per capita than Malta. Therefore, it is clear that Malta's R&D efforts lag significantly behind those of its European counterparts.

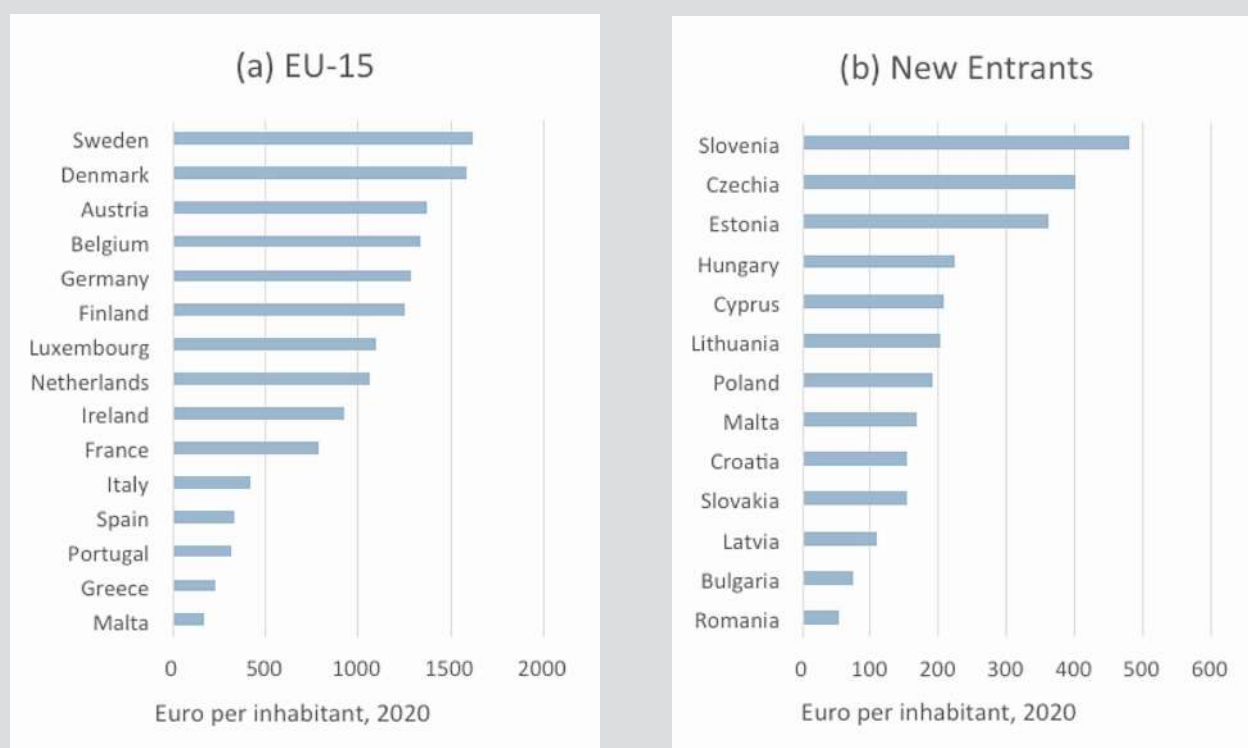
Nonetheless, it is important to note that Malta's GERD in 2020 increased by 75.2% relative to 2010, almost double the level of growth recorded in the EU and Euro Area on average, reflecting the country's significantly increased R&D efforts over this time, particularly over the period 2010-2015. A cursory glance at [Figure 3.3](#), shows that much of this increase has been driven by R&D within the business enterprise sector in Malta, which has grown by over 128.0% since 2010, accounting for over 64.0% of total GERD in 2020. Higher education institutions in Malta have also contributed heavily to this growth in R&D spending, registering a 115.0% increase between 2010 and 2020, with the sector now responsible for 35.2% of total GERD in Malta. On the flip side, expenditure on R&D within the public sector has shrunk by almost 63.0% since 2010, accounting for a negligible 0.5% of GERD in Malta, although this figure may be somewhat misleading given that the higher education sector in Malta is largely dominated by publicly run institutions like the University of Malta

Figure 3.1: GERD per inhabitant, 2010-2020



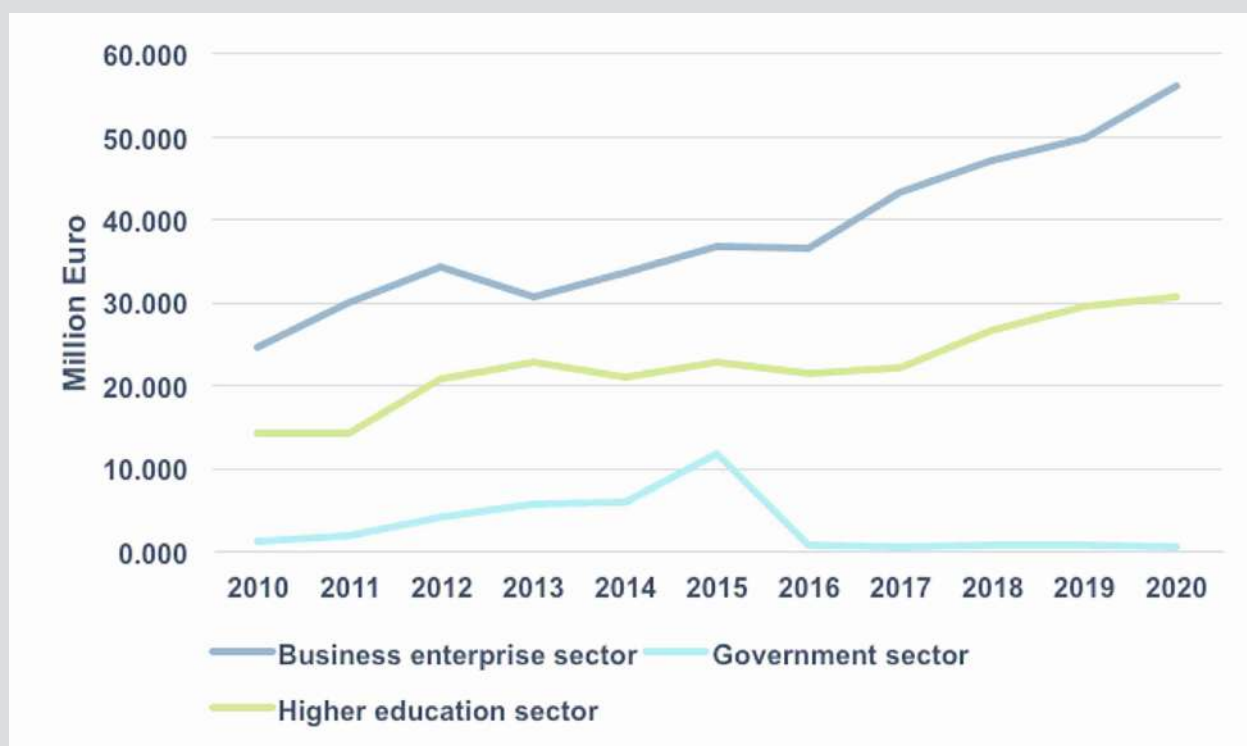
Source: Eurostat, 2022

Figure 3.2: GERD per capita in Malta relative to select EU countries



Source: Eurostat, 2022

Figure 3.3: GERD by sector in Malta, 2010-2020



Source: Eurostat, 2022

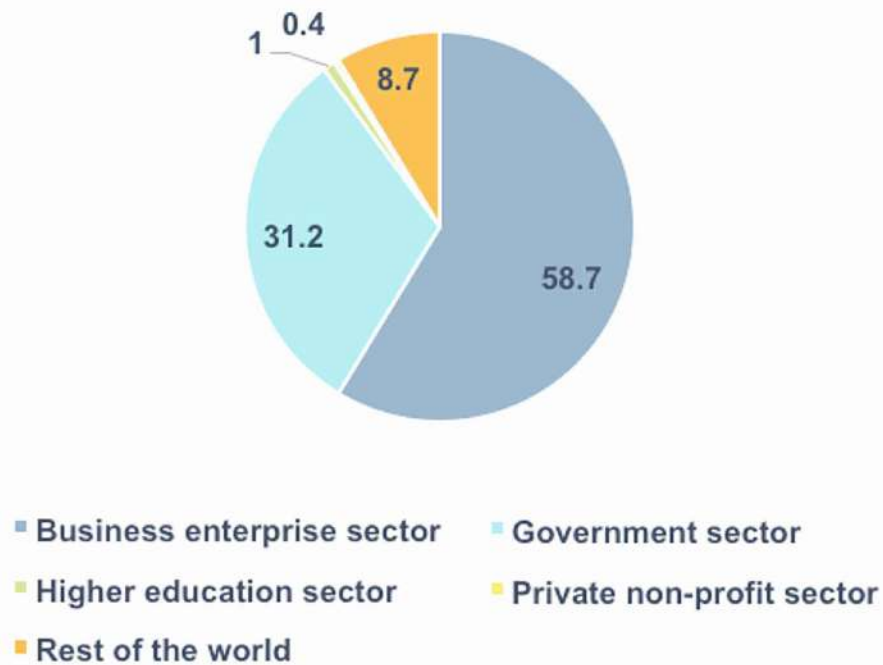
and MCAST. Furthermore, as shown in Figure 3.4, although the primary source of R&D funding in Malta is still the business enterprise sector (58.7%), the Government is responsible for around 31.2% of R&D funds, followed by external funds (8.7%) from the rest of the world. In total, Government expenditure on R&D in Malta accounts for approximately 0.5% of total government expenditure, a proportion that has remained relatively constant over the last ten years (Eurostat, 2022).

An important aspect to consider is the nature of the R&D activities that are currently being undertaken in Malta. As shown in Figure 3.5, the bulk of GERD in Malta is spent within the engineering and technology sector (43.8%), followed by natural sciences (25.2%) and medical and health sciences (13.8%). This reflects on the structure of Malta's business environment in recent years, with an increased focus on ICT and related fields, coupled with a growing presence of

high value-added manufacturing (Eurostat, 2022). The highest levels of growth have been recorded in natural sciences (135.0%), social sciences (135.0%) and natural sciences (127.5%). In terms of the type of research undertaken in Malta, Figure 3.6 shows that the majority of GERD is spent on basic research (51.2%), followed by applied research (34.4%) and experimental development (14.3%)³. By contrast, among EU countries the spread of GERD across these three types is much more even, with applied research accounting for 38.7% of average R&D spending, followed closely by experimental development (36.0%) and 25.2% spent on basic research (Eurostat, 2022). Therefore, it appears as though Malta's research profile varies to that of other EU member states, with a larger focus on initial, undirected research, and somewhat falls short on more experimental work that is more systematic and aimed at innovation for products or processes.

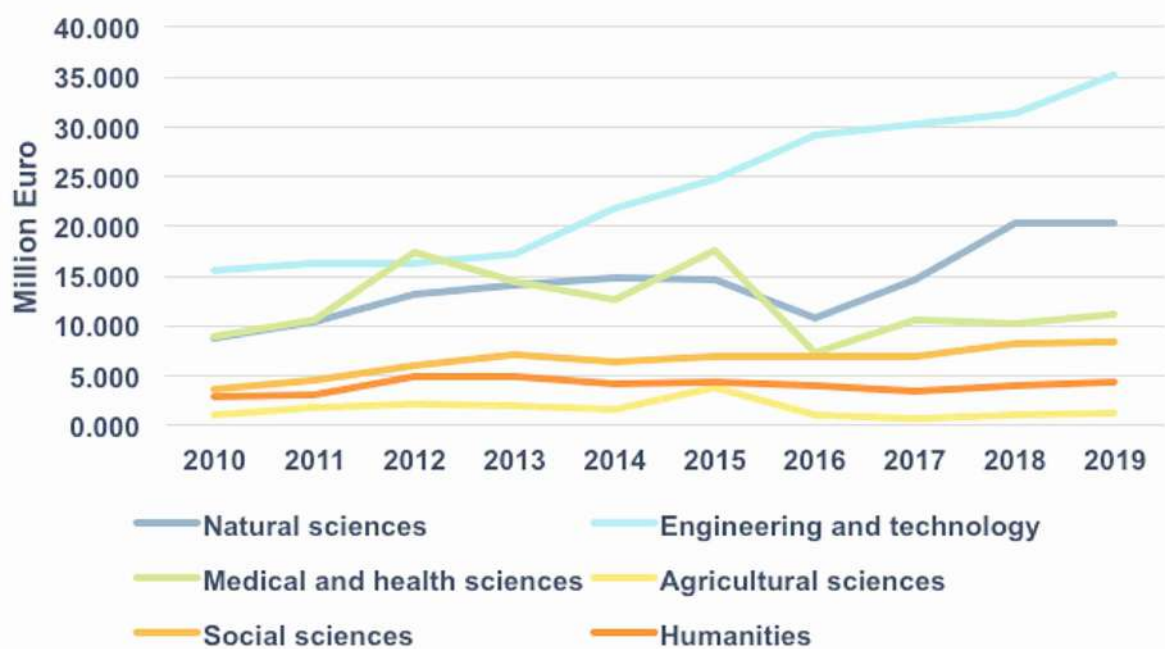
³ As per the definitions provided in the Frascati Manual (OECD, 2015, pp. 29), basic research is "experimental or theoretical work directed at gaining new knowledge of fundamental phenomena without any particular application or use in mind.," applied research is "new investigations directed towards a specific practical aim or objective," and experimental development is "systematic work directed towards improving or producing new products or processes, drawing on research and practical experience."

Figure 3.4: GERD by source of funds in Malta, 2020



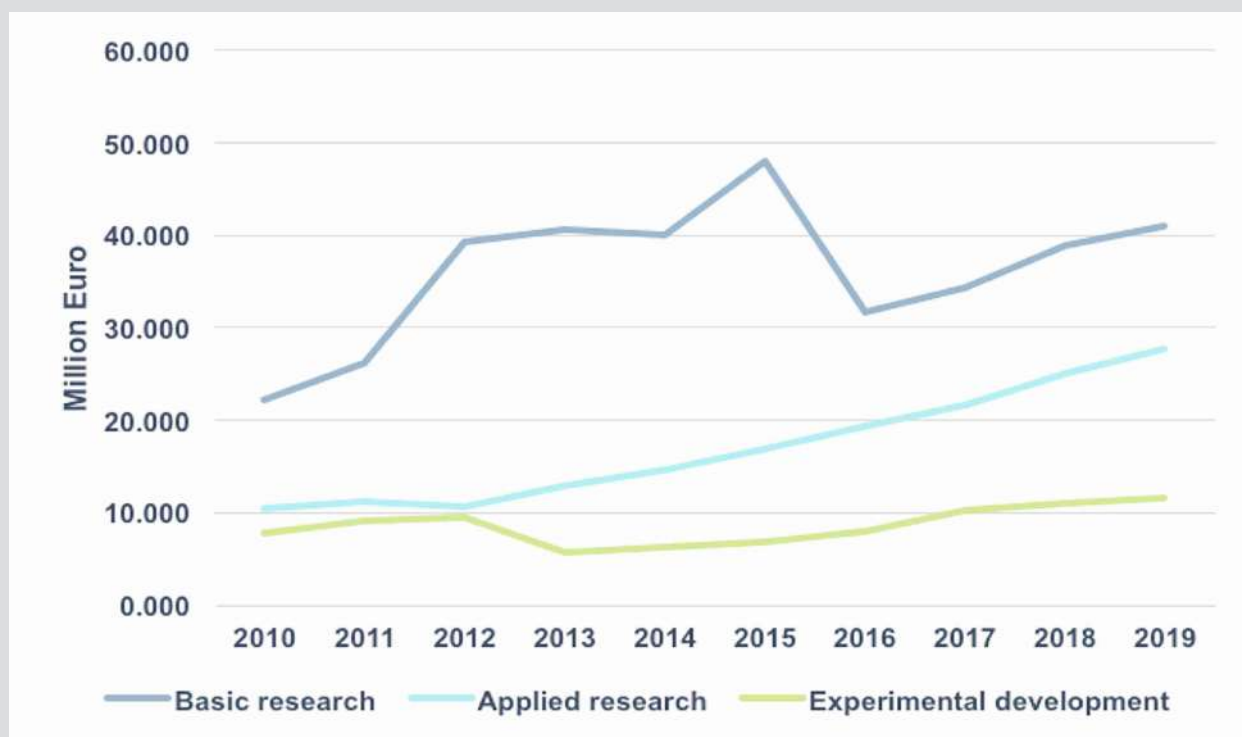
Source: Eurostat, 2022

Figure 3.5: GERD by field of science in Malta, 2020



Source: Eurostat, 2022

Figure 3.6: GERD by type of research in Malta, 2020



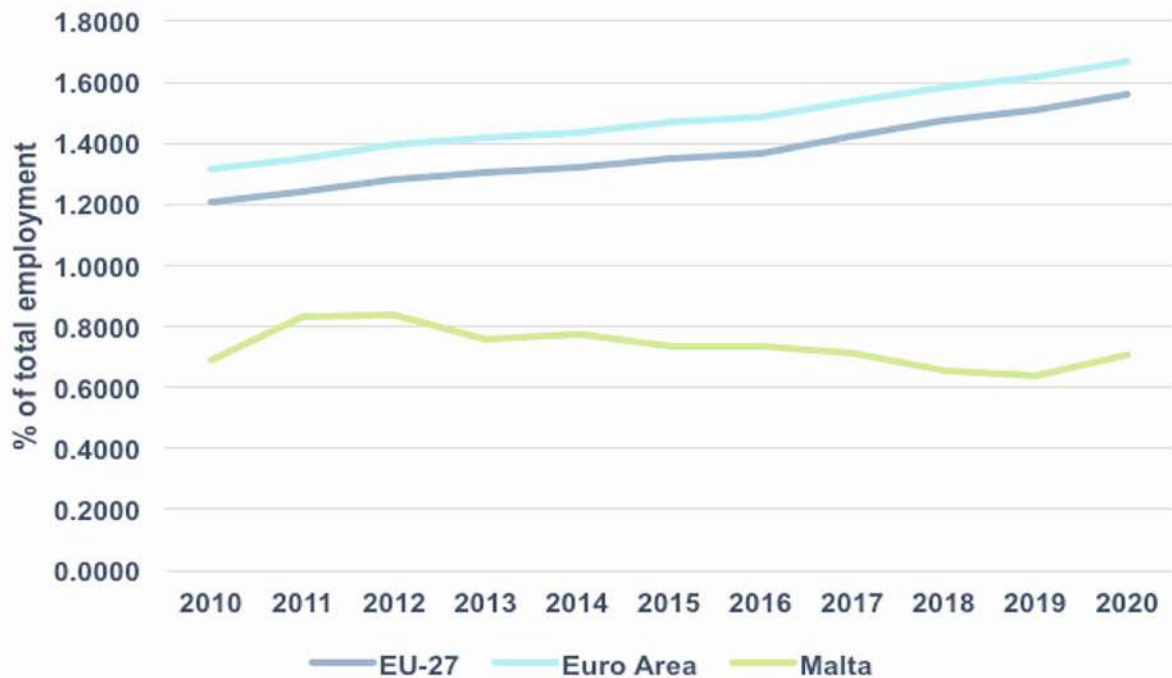
Source: Eurostat, 2022

3.1.2 R&D personnel

We now turn to analyse the extent to which human capital in Malta is gainfully employed within R&D. The number of total R&D workers as a percentage of total employment is shown in Figure 3.7. As seen below, in 2020 the share of R&D personnel reached 0.71%, which once again is significantly below the share within EU-27 and Euro Area countries (1.56% and 1.67% respectively), consistent with the lower levels of expenditure domestically. The overall trend in Malta has been relatively flat over the period under review, in contrast with the gradual upward trajectory experienced on average across the rest of Europe, despite the elevated levels of growth recorded in Malta's GERD over this period as reported earlier. Nonetheless, in absolute terms, the number of full-time equivalent R&D personnel in Malta increased by 64.0% between 2010 and 2020, significantly higher than the 35.3% and 31.6% levels of growth recorded within the EU-27 and Euro Area respectively (Eurostat, 2022). This apparent disconnect between growth in relative and absolute terms can be attributed to the

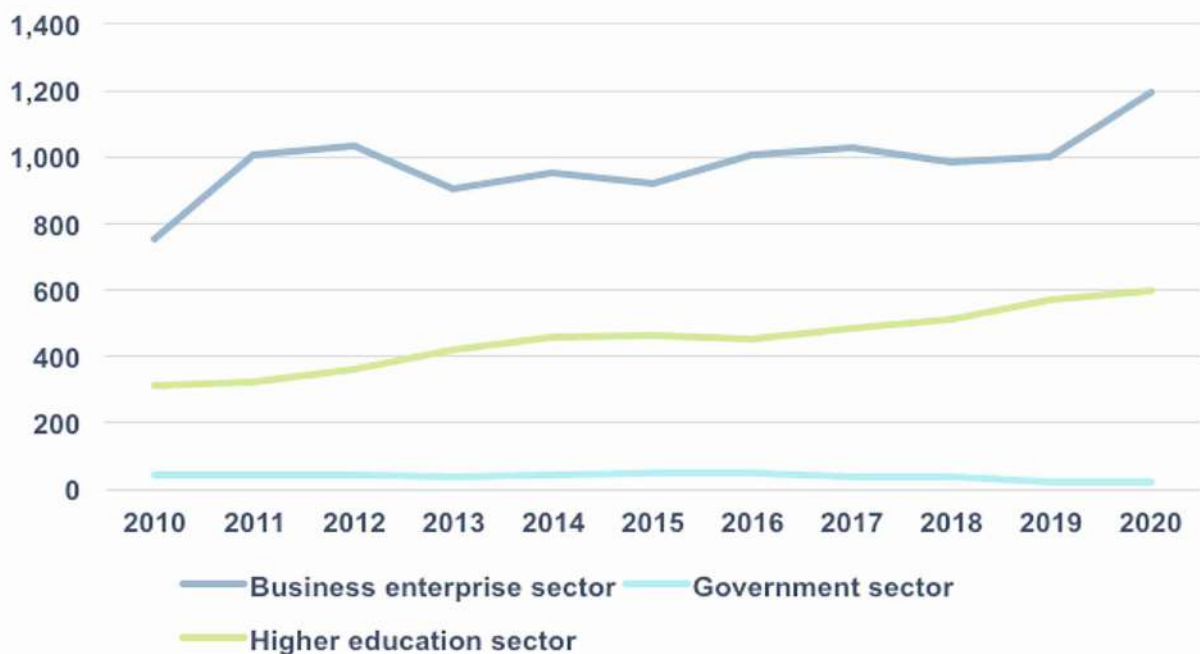
fact that over this period, Malta experienced unprecedented levels of growth in employment across virtually all sectors of the economy. This means that while growth in the number of R&D personnel employed in Malta grew substantially, their relative share in total employment remained fairly flat. Nonetheless, these data also indicate that on average, over the period under review, the European workforce underwent a gradual reconfiguration towards a more research-oriented focus, which will have implications for future competitiveness and innovation, particularly in light of the continued gap between domestic and European GERD.

Figure 3.7: R&D personnel as a % of total employment, 2010-2020



Source: Eurostat, 2022

Figure 3.8: R&D personnel (in FTE) by sector, 2010-2020



Source: Eurostat, 2022

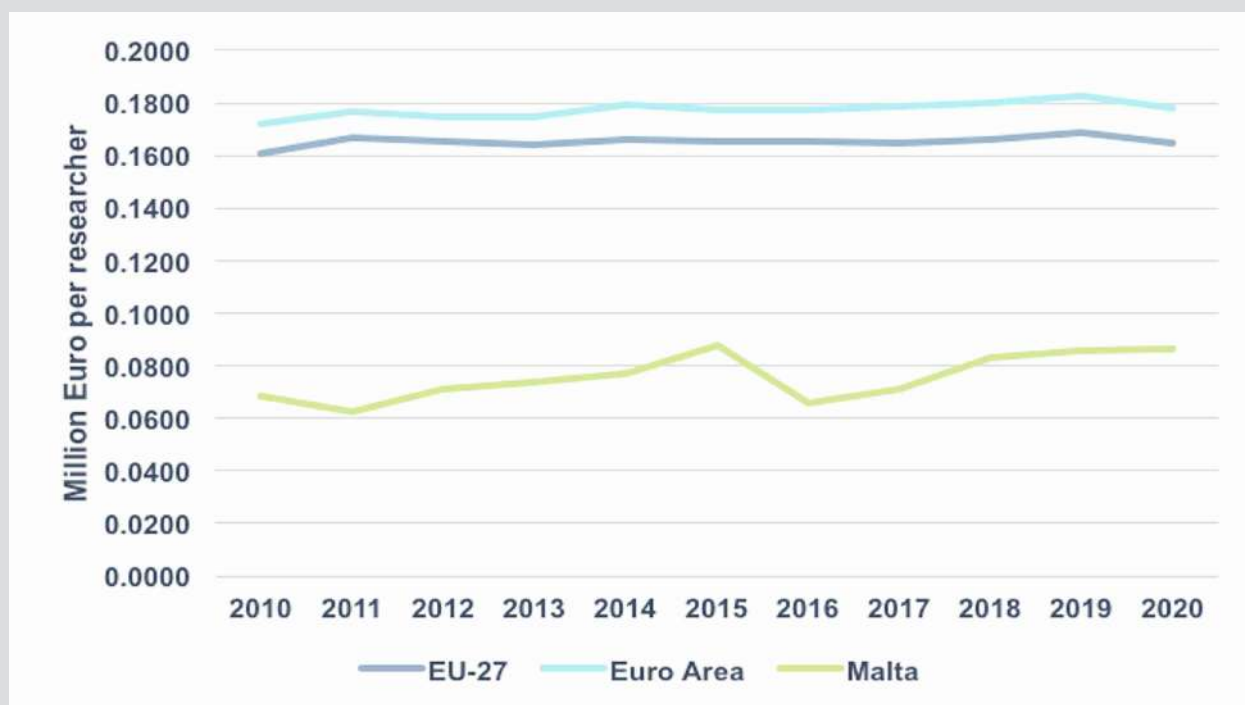
Figure 3.8 shows the breakdown of R&D personnel employed in Malta across different sectors. As shown below, once again the business sector dominates this field, accounting for over 66.0% of total R&D employment, recording an increase of just over 58.0% in 2020 relative to 2010 levels, mainly driven by an increase in researchers. The highest level of R&D personnel growth between 2010 and 2020 was reported in the higher education sector (91.6%), which now accounts for almost 33.0% of total employment, with the number of researchers more than doubling over this period. Conversely, R&D personnel in the Government sector shrunk by over 51.0% over the period under review, in line with the reduction in GERD within this sector.

At this point, it is worth considering the ratio of R&D expenditure to researchers, in order to understand the number of R&D funds that are handled on average by each researcher on an annual basis. This metric can be interpreted in several ways. Firstly, a high level of R&D spending per researcher indicates a strong concentration of funds across a limited number

of researchers, which means that overall R&D spending is significant, given existing human capital within the field. On the other hand, this may also indicate a relatively high research burden on existing researchers, and therefore the need for further investment in R&D personnel.

The ratio of GERD to researchers is shown in Figure 3.9. As seen below, Malta's GERD per researcher in 2020 stood at €0.09 million, significantly below the averages recorded in the EU and Euro Area of €0.16 and €0.18 million, respectively. Several observations can be extracted from these results. Firstly, from a human capital perspective the infrastructure is there to support significantly greater levels of R&D in Malta. Secondly, the results show that Malta's researchers are chronically under-funded, which may account for the greater focus on basic research as opposed to more advanced experimental development. Therefore, more efficient and productive use of Malta's research talent is required across all sectors of the economy, primarily through the provision of greater R&D funding.

Figure 3.9: R&D spending per researcher, 2010-2020



Source: Eurostat, 2022

Table 3.1: Potential R&D expenditure in Malta, 2020

	Business Enterprise Sector	Government Sector	Higher Education	Total
R&D Expenditure, million Euro	56.01	0.44	30.74	87.19
No. of Researchers - FTE	540	8	467	1,014
R&D Expenditure per Researcher, million Euro	0.10	0.06	0.07	0.09
Potential R&D Expenditure, million Euro	113.72	1.54	54.53	180.29
R&D Expenditure Gap, million Euro	-57.71	-1.10	-23.80	-93.10

Source: Eurostat, 2022; Authors' calculations

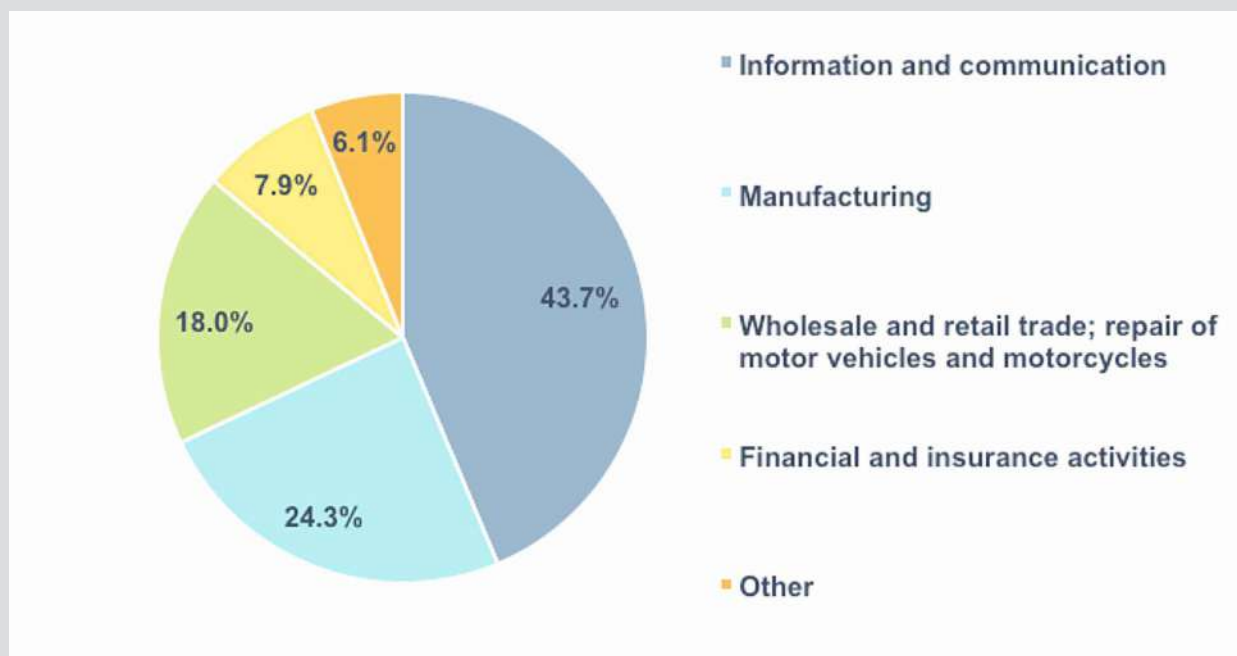
Indeed, we can calculate the potential R&D expenditure that should be present within the Maltese economy, given the current size of the Maltese researcher pool, based on the current spending capacities within the Euro Area⁴. This metric essentially asks the question: What is the level of R&D expenditure required to obtain the same level of R&D spending per researcher as the Euro Area average? This is done by multiplying the GERD per researcher for the Euro Area by the number of researchers in Malta, using the most recent data for 2020; this may be done across all sectors. In turn, we can calculate the current R&D spending gap across each sector, which provides us with a much clearer indication of the extent to which Malta is lagging when it comes to sectoral R&D spending, given current human capital. The results are shown in Table 3.1. Total GERD gap is equal to €93.1 million, meaning that R&D spending in Malta has the potential to increase by over 106.0%, given the number of researchers employed domestically. In fact, there is scope for significant improvement in GERD across all sectors, with the highest gap being in the Government sector (249.0%), followed by the business enterprise sector (103.0%) and the higher education sector (77.4%).

3.1.3 R&D expenditure by business

Given the importance of research and development expenditure by businesses, it makes sense to dig a little deeper to understand the key drivers and trends in this regard. Figure 3.10 shows the breakdown of business expenditure on R&D (BERD) in 2019 by sector. As shown below, the ICT sector dominates domestic BERD (43.7%), followed by the manufacturing sector (24.3%) and wholesale and retail, repair of motor vehicles and motorcycles (18.0%). R&D spending within the ICT sector has almost entirely been driven by investment in computer programming, consultancy, and related activities (99.1%), reflecting this sector's growing importance to the Maltese economy, which is likely to further grow as the country's digital transformation gathers pace over the coming years. Within the manufacturing sector, the largest share of R&D spending is attributable to the pharmaceutical industry (27.7%), despite a significant drop in expenditure within this sector in recent years, followed by the manufacture of motor vehicles, trailers and semi-trailers (19.8%), and the production of computer, electronic and optical products, as well as electronic components and boards (17.7% each). In terms of growth in R&D spending in recent years,

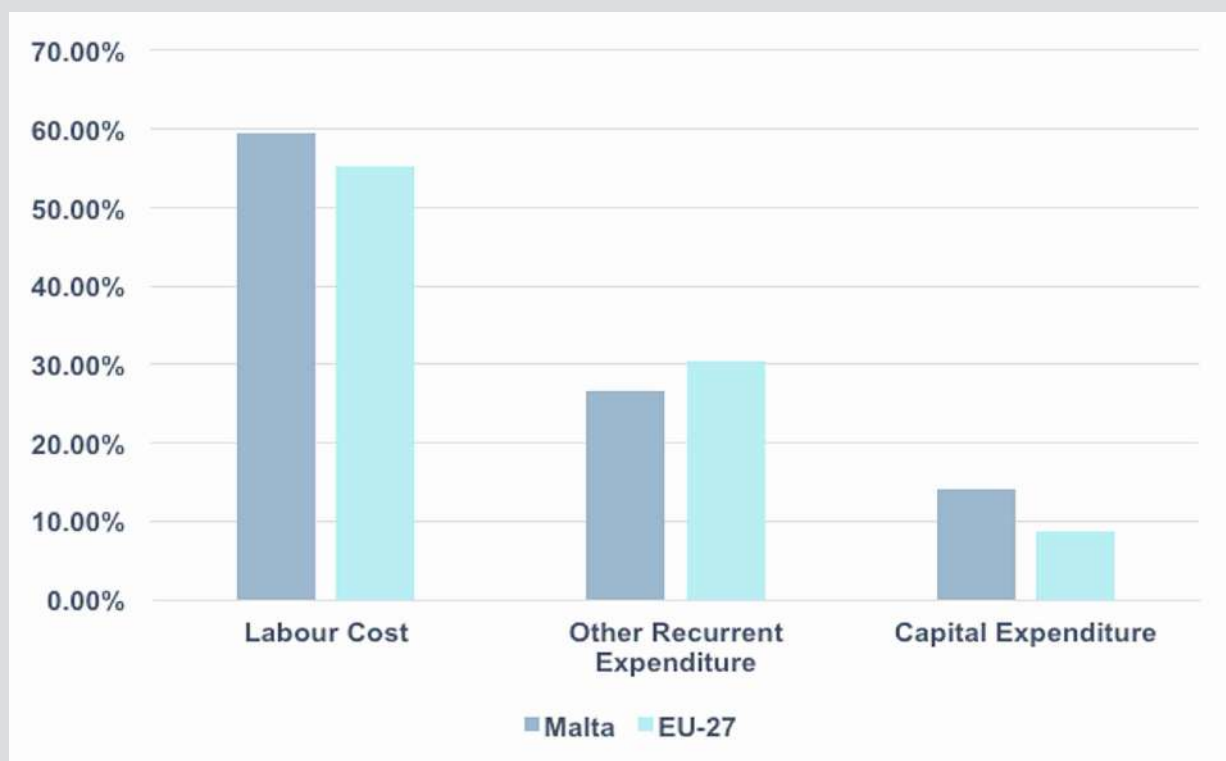
⁴ We use the Euro Area as our baseline since Malta has been part of the Euro Area since 2008.

Figure 3.10: Business R&D spending (BERD) by sector, 2019



Source: Eurostat, 2022

Figure 3.11: Business R&D spending (BERD) by type of expenditure, 2019



Source: Eurostat, 2022

Table 3.2: Business R&D expenditure in Malta by size, 2019

Size (No. of employees)	Annual BERD (million Euro)	BERD per business unit (Euro)	BERD as % of turnover	EU-27 Average BERD as % of turnover
0 to 9	4.40	91.91	0.05%	0.07%
10 to 49	11.52	4,496.10	0.15%	0.31%
50 to 249	29.21	56,167.31	0.54%	0.48%
250+	4.48	48,663.04	0.10%	1.01%

Source: Eurostat, 2022; Authors' calculations

between 2010 and 2019 the highest level of growth was recorded in wholesale and retail trade; repair of motor vehicles and motorcycles (+839.0%), followed by financial and insurance activities (+442.0%) and electricity, gas, steam, and air conditioning supply; water supply; sewerage, waste management and remediation activities (+262.7%). On the flip side spending in some sectors plummeted over this period, with the largest decrease recorded in the construction industry (-96.3%), despite the significant growth in economic activity recorded within this sector, followed by transportation and storage (-46.0%) and agriculture, forestry, and fishing (-43.0%), reflecting the sector's general decline in recent years.

We can now analyse the distribution of BERD in Malta according to business size. This is shown in Table 3.2 below, where medium-sized entities are responsible for the bulk of domestic annual BERD (59.0%), followed by small firms (23.2%) and large and micro firms (around 9.0% apiece). Indeed, medium-sized entities on average also invest the highest amount of annual BERD per firm at just over €56,000 per unit, somewhat higher than the €48,663 invested by large firms per unit, as well as the highest proportion of their total annual turnover (0.54%), dwarfing the proportion spent by both small (0.15%) and large (0.1%) firms. Indeed, middle-sized businesses in Malta spend a higher proportion of their turnover on R&D than the EU-27 average, which underscores the extent

to which these businesses are leading the way in terms of their contribution towards the research environment in Malta. Nonetheless, it is important to note that for all of the other size categories, the annual average BERD spent as a percentage of turnover in Malta is significantly lower than the EU-27 average, particularly among large businesses. This underscores the fact that these firms, which are almost entirely foreign owned, are underspending when it comes to BERD, when compared to their European counterparts.

This may be due to a variety of reasons. Firstly, the highest number of large businesses in Malta operate within administrative and support services (24.0%; NSO, 2022), which relative to other sectors is somewhat limited in terms of its scope for investment in R&D, given that such firms typically support the work done by other businesses. Secondly, and perhaps more crucially, as cited in Malta's National Research and Innovation Strategy for 2020, the lack of large-scale research infrastructure in Malta, including public research institutions and a lack of researchers, may dissuade firms from investing heavily in R&D facilities, particularly foreign businesses that are established in Malta and which may have access to sophisticated R&D infrastructures abroad.

We conclude by looking at BERD by type of expenditure, with the results shown in Figure 3.11.

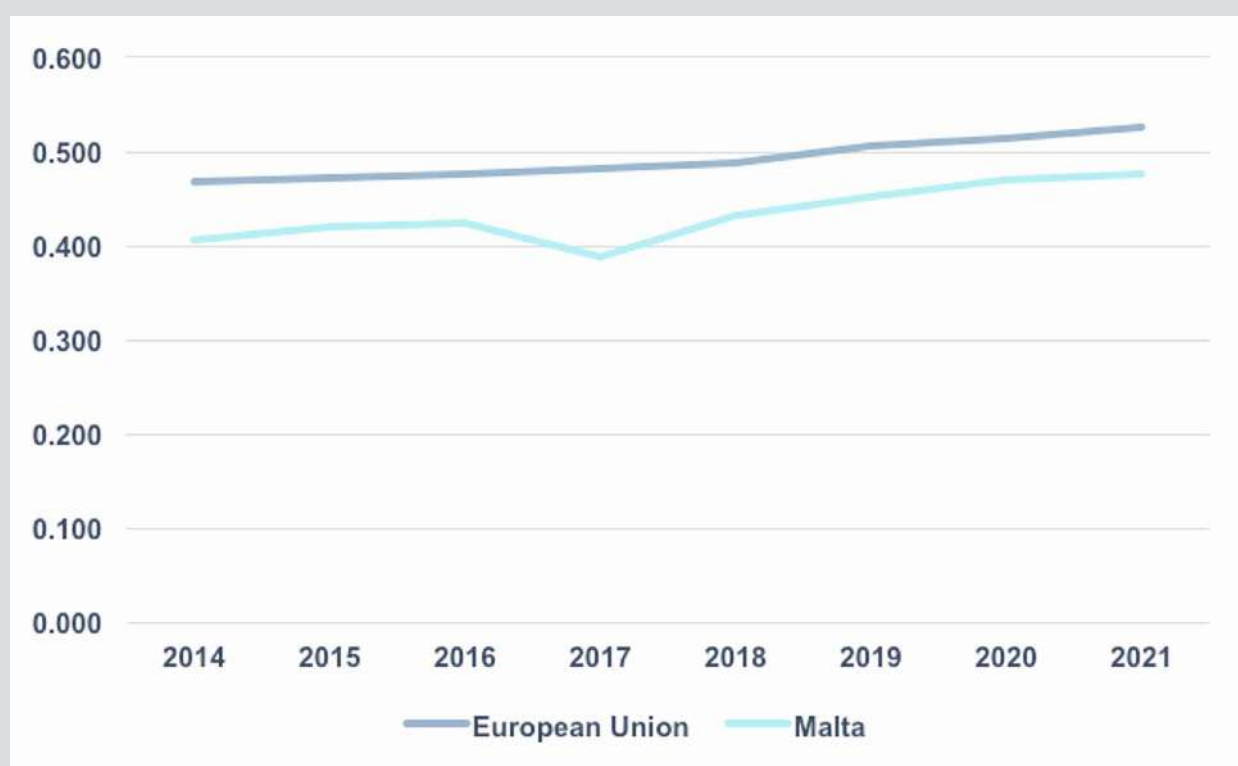
The composition of BERD in Malta's largely comparable to the rest of the EU-27, with the bulk of expenditure allocated towards labour costs (59.4%), followed by other recurrent expenditure (26.52%) and capital spending (14.1%). It is worth noting that the proportion of BERD allocated towards capital expenditure in Malta is almost 63 percentage points higher than the EU-27 average, indicating that businesses are investing a higher proportion of their R&D spending on expanding and upgrading their physical R&D infrastructure.

3.2 Measures of innovation

3.2.1 European Innovation Scoreboard

We now shift our attention towards recent trends in Malta's innovation performance, as captured by a variety of indicators. The key metric used by the EU to gauge and compare progress in innovation is the annual European Innovation Scoreboard (EIS). The EIS provides a comparative analysis of innovation performance in EU countries, other European countries, and regional neighbours. It assesses the relative strengths and weaknesses of national innovation systems and helps countries identify areas they need to address in their efforts to boost their innovation performance. The EIS provides an aggregate score for innovation across each country, which is calculated on the basis of four main pillars, namely innovation framework conditions, investments, innovation activities and impacts. In

Figure 3.12: Summary innovation index, 2014-2021



Source: EIS, 2022

turn, each pillar is subdivided into three innovation dimensions, which in total comprise 32 indicators across all dimensions. The EIS and its composites range from 0 to 1, with values closer to 1 indicating a higher level of performance within the field in question.

We start with the summary innovation index, as depicted below in [Figure 3.12](#). Malta's innovation performance since 2014 has improved by over 17.0%, relative to the EU average of 12.5%. Nonetheless, despite this improved score, Malta has dropped one place in the overall EU innovation ranking, from 13th in 2014 to 14th in 2021. This means that the country lies squarely in the middle of the pack when it comes to innovation, above countries like Spain, Portugal and many of the new entrants that had joined the EU (together with Malta) in 2004, but below the more established EU economies like Sweden, Germany and France.

[Table 3.3](#) breaks down Malta's EIS score by the various pillars of innovation as defined in the EIS methodology, which collectively accounts for the summary innovation index. As seen below, Malta scores above the EU average in exactly half of the indicators, namely digitalisation, information technologies, innovators, intellectual assets, employment impacts and environmental sustainability. For digitalisation, Malta scores highly in both broadband penetration and the proportion of individuals with above-basic digital skills, which should provide a strong foundation for the continued digitalisation of the Maltese economy, and which may have assisted in cushioning the blow from COVID-19 and the ensuing digital shift in work practices. With regards to information technologies, Malta performs well in terms of the number of enterprises providing ICT training as well as the number of employed ICT specialists, reflecting recent growth within this sector domestically. In terms of innovators, despite its size, Malta scores highly when it comes to the number of SMEs introducing product

Table 3.3: European innovation scoreboard breakdown, 2021

Innovation Indicator	2021 Score	2021 EU Average Score	2021 Ranking	2014 Ranking
Human resources	0.336	0.440	18 th	25 th
Research systems	0.388	0.464	17 th	20 th
Digitalisation	0.750	0.624	8 th	6 th
Finance and support	0.076	0.571	26 th	20 th
Firm investments	0.281	0.594	22 nd	11 th
Information technologies	0.679	0.491	8 th	11 th
Innovators	0.631	0.612	15 th	11 th
Linkages	0.429	0.446	17 th	17 th
Intellectual assets	0.510	0.416	9 th	6 th
Employment impacts	0.597	0.490	10 th	7 th
Sales impacts	0.414	0.621	21 st	18 th
Environmental sustainability	0.869	0.579	1 st	11 th

Source: EIS, 2022

innovations, perhaps a reflection of the relatively high levels of R&D spending reported by medium enterprises, with significant growth also recorded in the number of SMEs introducing business process innovations. As far as intellectual assets are concerned, although Malta scores poorly when it comes to the filing of international (PCT) patents, the country leads the way within the EU for trademark applications by a wide margin, and also scores well for design applications, although these have decreased significantly in recent years.

Therefore, it appears as though the intellectual assets score is somewhat skewed by the massive number of trademark and design applications submitted within the country, as opposed to patent applications. Indeed, in 2017 a total of 14.4 patent applications per million inhabitants were filed to the European Patent Office (EPO) by Maltese entities, some way off the EU and Euro Area averages of 106.8 and 127.88 respectively, potentially reflecting the lack of R&D expenditure locally, particularly when it comes to experimental development, which is typically associated with the creation of patentable discoveries.

In terms of employment impacts, this is driven by high levels of employment in knowledge-intensive activities like telecommunications, information service activities, and human health activities. Finally, but crucially, Malta is the top-performing country in the EU when it comes to environmental sustainability, recording high levels of relative resource productivity, low emissions of fine particulate matter (PM_{2.5}) and particularly high development of environment-related technologies, relative to total patent submissions, mainly in renewable energy, energy-efficient buildings, and the ocean economy.

On the other side, Malta is somewhat lacking when it comes to human resources, research systems, finance and support, firm investments, linkages, and sales impacts. For human resources, the score is driven down by Malta's low level of new doctorate graduates; for research systems, this reflects relatively low levels of international scientific co-publications and low proportions of scientific publications among the top 10% of most-cited articles. Malta performs particularly poorly in finance and support, reflecting

low levels of R&D spending in the public sector, Government support of business R&D as well as weak venture capital expenditure. In a similar vein, Malta's firm investment performance is driven by low BERD, non-R&D innovation spending and low innovation spending per person employed, clearly related to the previous analysis on Malta's R&D spending. Despite the geographical proximity of most places in Malta, the country has relatively low levels of linkages, driven by weak collaborations between innovative SMEs and public-private co-publications. Finally, the low sales impacts scores reflect relatively low exports of medium- and high-technology products and knowledge-intensive services exports, as well as low sales of new-to-market and new-to-firm innovations.

3.2.2 Global innovation index

Another important measure of country-level innovation used internationally is the Global Innovation Index (GII). The GII is a global metric developed by the World Intellectual Property Organisation that seeks to capture a holistic picture of innovation within countries across the world. Like other indices of this kind, the GII provides a single overall score for innovation within countries, which in turn is derived from seven pillars, namely institutions, human capital and research, infrastructure, market sophistication, business sophistication, knowledge and technology outputs and creative outputs, each including a number of further sub-pillars, comprising of 81 indicators in total. The GII scores range from 0 to 100, with higher values denoting higher levels of performance within the specific domain in question.

Figure 3.13 presents the summary GII score for Malta over the period 2013 to 2021. As seen below, Malta's GII score has in general remained fairly constant, although it has fallen slightly from 51.8 in 2013 to 47.1 in 2021. Indeed, Malta's global ranking in the GII has fallen by three places since 2013, attesting to the relative innovation stagnation over this period as captured by the various indicators and pillars included in the GII. Nonetheless, it is worth noting that Malta's GII score is almost identical to the EU-27 average of 47.3, with the country ranking 13th in the GII among EU member states, similar to the EIS ranking. Therefore, based on both the EIS and GII, it

is evident that Malta's innovation performance in recent years can be classified as medium, with significant progress in some areas as well as scope for further improvements in others.

Table 3.4 breaks down Malta's GII performance across each of the seven pillars that comprise the final GII score. As seen below, Malta currently exceeds the EU average in three domains, namely infrastructure, business sophistication and creative outputs. We start with infrastructure, where Malta's key strengths lie in ICT access and use (ranked 5th and 13th globally, respectively) and ecological sustainability (ranked 3rd globally), driven in particular by energy resource productivity, captured by GDP generated per unit of energy use (3rd globally). Indeed, as seen below Malta has recorded significant progress when it comes to the quality of its infrastructure, mainly as a result of improvements within these aforementioned domains. Nonetheless, it is worth noting that despite these positive results, the quality of Malta's general infrastructure is still considered to a certain degree

low, mainly in terms of its perceived weaknesses when it comes to logistics as captured by the World Bank's Logistics Performance Index (ranked 68th globally), which incorporates customs performance, infrastructure quality and timeliness of shipments, plummeting 26 places since 2013.

Next, we turn to business sophistication, where Malta scores highly in terms of knowledge-intensive employment (19th globally), the proportion of firms offering formal training opportunities (18th globally) and the proportion of research and development expenditure funded by businesses (14th globally). Malta also scores highly in terms of the number of patent families filed by residents per billion dollars of GDP generated annually (18th globally), as well as the number of joint ventures and strategic alliances made annually per billion dollars of GDP generated (1st globally). Finally, as part of this pillar, Malta also performs well in terms of intellectual property payments received as a percentage of total trade (4th globally), net inflows of foreign direct investment

Figure 3.13: Global innovation index score for Malta, 2013-2021



Source: WIPO, 2013-2021

(joint 1st globally) and the proportion of researchers employed by the business enterprise sector (19th globally).

Finally, another key strength in Malta's innovation score comes from its creative output. Once again this is driven by the number of trademarks filed per billion dollars of GDP annually (5th globally), exports of cultural and creative services as a proportion of total trade, largely due to Malta's thriving gaming industry (1st globally), the number of nationally-produced feature films as a proportion of the working-age population (7th) and the proportion of manufacturing GVA emanating printing and other recorded media (1st globally). In addition, Malta also does well when it comes to online activities, particularly in terms of the registration of generic top-level online domains per thousand working age population (3rd globally) and the number of downloads for mobile apps whose developers are headquartered in Malta, per billion dollars of GDP annually (26th globally), once again reflecting Malta's strengths in gaming and ICT.

On the flip side, as seen in [Table 3.4](#), Malta currently lags behind the average of the EU in four domains, namely institutions, human capital and research, market sophistication and knowledge and technology outputs. When it comes to institutions, Malta's key weaknesses as identified by the GII lie with the (lack of) ease of starting a business, with the country ranking 69th globally, and the ease of resolving business insolvency, with the country placed 105th globally, thereby pointing towards issues with Malta's business institutional environment, which may hamper entrepreneurship and innovative start-ups. It is worth pointing out that when it comes to the ease of starting a business, Malta has recorded significant improvements since 2013, when Malta was ranked 104th globally, although the opposite is true for business insolvency resolution where Malta has plummeted 45 places since 2013.

Turning to human capital and research, Malta scores somewhat poorly in relation to expenditure on education as a proportion of GDP (46th globally) and PISA scales in reading, maths and science (42nd globally), which points towards the need for targeted investment in education, especially in STEM subjects.

This is further reflected in Malta's tertiary education scores, with relatively low rankings obtained in tertiary enrolment rates (41st globally) and in particular the proportion of science and engineering graduates (69th globally), which further highlights the need for STEM educational investment and promotion. Finally, as discussed earlier, Malta scores low in terms of gross expenditure on research and development as a proportion of GDP (59th globally), while the quality of the country's tertiary education institutions as captured by the QS World University Rankings (74th globally) has also been identified as an important weakness.

Malta's worst performance in the GII lies within the market sophistication domain. A key driver in this regard is the country's very low scores in terms of the ease with which credit can be obtained (118th globally). Based on both the legal rights of borrowers and lenders (collateral and bankruptcy laws) as well as the coverage, scope, and accessibility of credit information available through credit reporting service providers. Malta's performance in this domain has improved significantly since 2013 (ranked 139th globally), although it is evident that there is still room for significant improvements. Malta also scores relatively poor on the extent of conflict-of-interest regulation (protection of shareholders against directors' misuse of corporate assets) and the extent of shareholder governance (shareholders' rights in corporate governance), ranked 50th globally, although this is somewhat offset by the country's positive results on both the value of venture capital investments and receipts per billion dollars of GDP (ranked 13th and 16th globally). Predictably, Malta obtains very low scores for the scale of the domestic market (127th globally), reflecting the country's small size and international outlook.

Finally, knowledge and technology outputs have also been identified as an important area of weakness for Malta's innovation performance, with a significant decline recorded in the country's ranking within this domain since 2013 as seen in [Table 3.4](#). A key driver of this weak performance has been Malta's low labour productivity growth, with Malta ranking 115th globally, the lowest within the EU-27 and Euro Area. Malta also ranks low for ICT services exports (96th globally),

Table 3.4: Global innovation index breakdown, 2021

GII Pillar	2021 Score	2021 EU Average Score	2021 Ranking	2013 Ranking
Institutions	73.9	79.1	37 th	23 rd
Human capital and research	39.3	47.1	41 st	62 nd
Infrastructure	56.4	54.8	18 th	42 nd
Market sophistication	47.0	52.1	63 rd	61 st
Business sophistication	53.7	43.5	14 th	13 th
Knowledge and technology outputs	28.3	39.0	44 th	14 th
Creative outputs	52.0	39.4	9 th	6 th

Source: GII, 2022

the proportion of high-tech exports (41st globally), the number of scientific journal articles published annually per billion dollars of GDP (44th) and the number of highly cited published articles as captured by the h-index (91st globally). On the other hand, it is worth noting that Malta scores highly when it comes to the number of new businesses per thousand population (6th globally) and intellectual property income as a proportion of total trade (9th globally), which point towards Malta's burgeoning reputation as a hub for innovative start-ups.

3.3 Sectoral innovation

To round off the discussion on innovation, one should take a look at sectoral performance in relation to innovative activities within Malta, as captured by the 2018 wave of the EU's Community Innovation Survey (CIS). The CIS is a reference, biennial survey designed to provide information on the innovativeness of business economy sectors, to enable the analysis of innovation drivers or barriers or to assess innovation outcomes. The key results are shown in Table 3.5. As shown below, the ICT sector has the highest proportion of innovative enterprises currently in operation with 64.1%, followed by financial services (54.1%) and manufacturing (46.0%). This partly reflects the extent of R&D expenditure within these sectors, since as mentioned earlier these three sectors are among the highest spenders when it comes to BERD in Malta, thus confirming the link between R&D and innovation. These sectors also reported the highest proportion of enterprises with completed innovation activities, as well as a high proportion of enterprises with ongoing innovation activities, indicating that these high levels of both BERD and innovation look set to continue in the future. On the other end of the scale, the sectors with the lowest proportion of innovative firms are water supply

(22.2%), accommodation and food services (24.9%) and agriculture (25.0%), which once again are also in line with the low levels of R&D spending within these sectors. This is also reflected in the proportion of enterprises with either completed or ongoing innovation activities in these sectors, which are extremely low in all cases, indicating that there does not seem to be an active plan to improve innovation or raise R&D spending within these sectors.

Given these results, it is important to understand what are the key barriers that hamper the undertaking of innovative activities across each sector in Malta. Table 3.6 shows the proportion of firms across each sector that rated a number of different barriers as 'high' in terms of their relative impact. As seen below,

the most highly cited barrier was 'different priorities within the enterprise', followed closely by 'high competition', with the other factors lagging significantly behind the top two. Therefore, it appears as though innovation (and by extension BERD) is simply not a priority for a vast number of enterprises in Malta, implying that businesses in Malta are largely focused on short-term objectives and goals rather than longer-term ambitions. Within the low-innovation sectors, agriculture and fisheries entities also cited 'high costs' as a barrier, while in water supply and waste management a variety of barriers were mentioned, including lack of internal and external finance, and lack of qualified employees and collaborators. Interestingly, none of the survey respondents mentioned: 'difficulties in obtaining

Table 3.5: Innovative activities by sector, 1998

	Innovative enterprises (%)	Enterprises with completed innovation activities (%)	Enterprises with ongoing innovation activities (%)
Agriculture, forestry and fishing	25.0	12.5	0.0
Manufacturing	46.0	44.9	17.4
Water supply; sewerage, waste management and remediation activities	22.2	22.2	0.0
Construction	25.5	23.4	6.6
Wholesale and retail	33.5	32.5	11.6
Transportation and storage	32.4	32.4	10.3
Accommodation and food service activities	24.9	20.8	7.5
ICT	64.1	62.0	23.2
Financial services	54.1	52.5	14.8
Real estate	41.2	38.2	14.7
Professional services	42.8	38.0	16.7
Administrative and support service activities	34.7	31.7	13.9

Source: Eurostat, 2018

public grants or subsidies', 'uncertain market demand' or 'lack of access to external knowledge' as barriers to innovation. This suggests that the lack of public funding for R&D mentioned earlier is not necessarily related to limited spending by Government authorities per se, but rather a result of limited private sector take-up of public research funding provided by the likes of Malta Enterprise.

Table 3.6: Barriers to innovative activities by sector, 1998

	Lack of internal finance	Lack of external finance (credit or private equity)	High costs	Lack of qualified employees within enterprise	Lack of collaboration partners	Difficulties in obtaining public grants or subsidies	Uncertain market demand	High competition	Lack of access to external knowledge	Different priorities within the enterprise
Agriculture, forestry and fishing	0.0	0.0	12.5	0.0	0.0	0.0	0.0	12.5	0.0	12.5
Manufacturing	8.0	4.5	11.8	20.9	2.1	6.6	9.4	17.1	1.7	11.8
Water supply; sewerage, waste management and remediation activities	11.1	11.1	11.1	11.1	11.1	0.0	0.0	11.1	0.0	11.1
Construction	4.4	3.6	10.2	14.6	3.6	1.5	4.4	12.4	3.6	11.7
Wholesale and retail	5.6	3.4	9.6	11.6	3.2	4.9	3.4	14.3	2.9	8.9
Transportation and storage	4.4	1.5	7.4	7.4	0.7	2.9	2.2	8.1	0.7	8.1
Accommodation and food service activities	4.0	3.2	8.4	9.0	2.9	3.5	2.9	11.6	2.3	6.1
ICT	11.3	4.2	11.3	14.8	3.5	7.0	5.6	12.0	1.4	16.2
Financial services	3.3	0.8	3.3	5.7	0.8	0.8	2.5	1.6	0.8	12.3
Real estate	5.9	2.9	14.7	11.8	2.9	5.9	2.9	11.8	2.9	17.6
Professional services	5.8	2.9	8.3	9.8	3.6	4.3	4.3	6.2	1.8	10.5
Administrative and support service activities	9.9	6.9	9.9	8.9	2.5	9.4	4.5	11.4	2.0	5.9

Source: Eurostat, 2018

3.4 Productivity and competitiveness

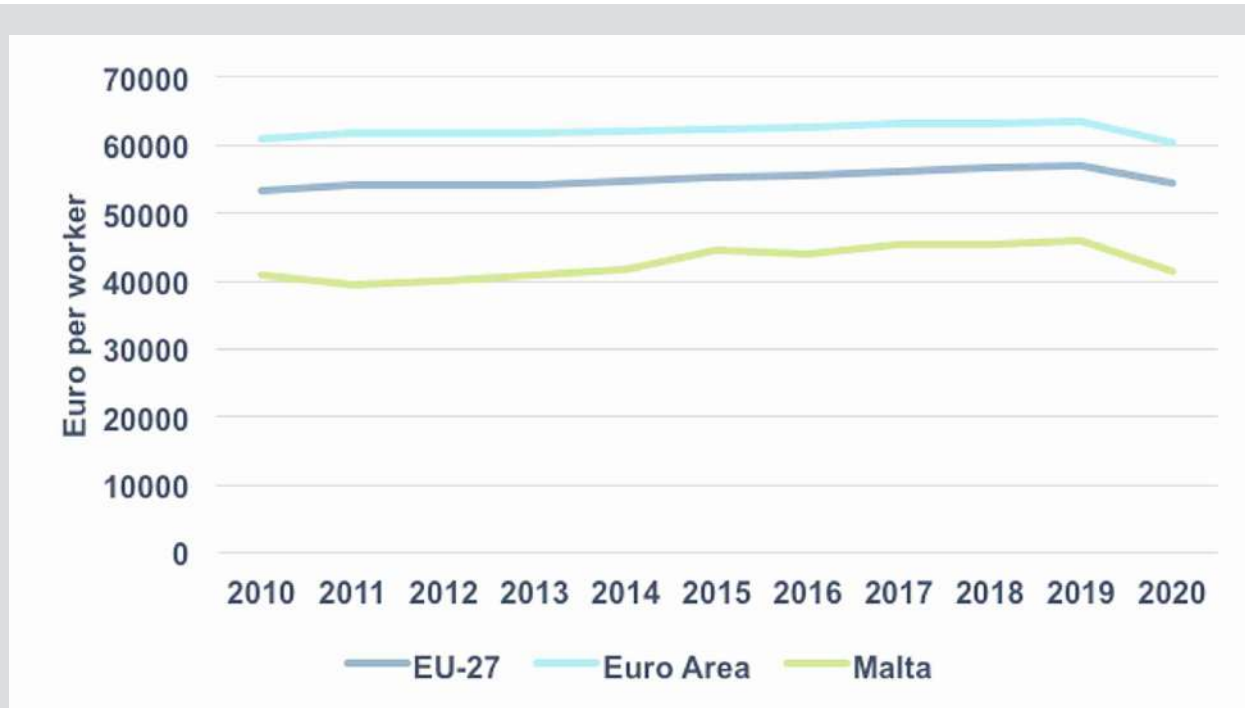
3.4.1 Labour productivity

This section provides a detailed comparison of the economic characteristics of the key sectors in the Maltese economy, with a specific focus on productivity performance as it relates to competitiveness.

We begin by analysing aggregate labour productivity, whereby productivity is defined as real GVA (at constant 2015 prices) per worker, as depicted in Figure 3.14. Productivity growth between 2010 and 2019 has been steady if unspectacular both in Malta as well as across the EU-27 and Euro Area countries, before the inevitable dip in 2020 due to the pandemic. Indeed, between 2010 and 2019 real labour productivity in Malta grew by 12.8%, somewhat above the EU-27 and Euro Area averages of 7.1% and 4.0% respectively, reflecting the fact that Malta's elevated levels of economic growth over this period were accompanied by above-average gains in labour

productivity, although much of this growth is concentrated over the 2011-2015 period, with relative stagnation thereafter. On the other hand, Malta also suffered a higher-than-average dip in productivity between 2019 and 2020 as a result of the COVID-19 pandemic, falling by 9.9% relative to the EU and Euro Area averages of 4.6% and 4.9% respectively. This reflects the obvious slowdown in economic activity precipitated by the pandemic, coupled with the success of the government's wage supplement scheme which meant that many firms did not lay off workers despite the decline in output. It is also worth noting that despite the above-average growth recorded over most of this period, Malta's real labour productivity of €41,381 per worker is still some way off the EU and Euro Area averages of €54,256 and €60,333 per worker respectively, which indicates that there is still some way to go before Malta's productivity levels catch up with those of many of its European counterparts.

Figure 3.14: Real labour productivity, 2010-2020



Source: Eurostat, 2022; Authors' calculations

Table 3.7: Real labour productivity in Malta by sector

	Real Labour Productivity 2019 (Euro per worker)	Real Labour Productivity 2020 (Euro per worker)	Growth, 2010- 2019 (%)
Agriculture, forestry and fishing	26,403	21,892	-28.9%
Manufacturing	37,853	37,809	8.1%
Water supply; sewerage, waste management and remediation activities	54,098	52,071	27.3%
Construction	33,079	30,260	17.5%
Wholesale and retail trade; repair of motor vehicles and motorcycles	34,056	30,967	33.1%
Transportation and storage	45,735	24,068	17.0%
Accommodation and food service activities	32,683	9,635	15.0%
Information and communication	117,387	124,384	117.6%
Financial and insurance activities	78,246	82,190	13.9%
Real estate activities	233,525	216,864	-46.4%
Professional, scientific and technical activities	67,167	61,729	39.3%
Administrative and support service activities	33,843	28,256	10.9%
Public administration and defence; compulsory social security	34,876	35,809	12.1%
Education	26,725	25,666	-16.1%
Human health and social work activities	35,008	33,010	0.3%
Arts, entertainment and recreation	75,920	74,729	-58.2%

Source: Eurostat, 2022; Authors' calculations

We now turn to Malta's real labour productivity by sector, shown in [Table 3.7](#). As seen below, Malta's top-performing sector when it comes to real labour productivity is real estate, with a GVA of €216,864 generated per worker in 2020, reflecting the significant growth recorded within the Maltese housing market in recent years characterised by consistently-rising house and rental prices, although productivity within this sector has fallen somewhat between 2010 and 2019 indicating a mean-reverting trend.

The second-best performer for labour productivity is the ICT sector with a GVA per worker of €124,384 in 2020, with this sector also recording the highest level of productivity growth over the period 2010-2019 in Malta, which comes as no surprise given the growth levels recorded within ICT in recent years as well as the Maltese economy's digital transition. Other notable high-productivity sectors include financial services and insurance (€82,190), arts, entertainment and recreation, which largely captures the gaming industry (€74,729) and professional, scientific and technical activities (€61,729). While both financial services and professional services have experienced steady growth in productivity in recent years, the gaming industry has by contrast experienced a marked drop in labour productivity, which may also be due to market adjustment towards its long-term equilibrium following years of over-performance. On the flip side, the lowest-productivity sector in Malta is agriculture, forestry and fishing, with a GVA per worker of €21,892 in 2020. This low level of productivity is in line with the steady general decline experienced within this sector in recent years, also attested by the drop in productivity between 2010 and 2019 of 28.9%. Other low-productivity sectors include administrative and support services (€28,256) and construction (€30,260), although both sectors have recorded double-digit levels of productivity growth between 2010 and 2019.

Two sectors that merit a separate mention are transportation and storage and accommodation and food services, which both recorded the lowest levels of labour productivity in Malta in 2020 following anomalously-large drops in productivity between 2019 and 2020. In both cases, this is due to the disproportionately-deleterious impact that

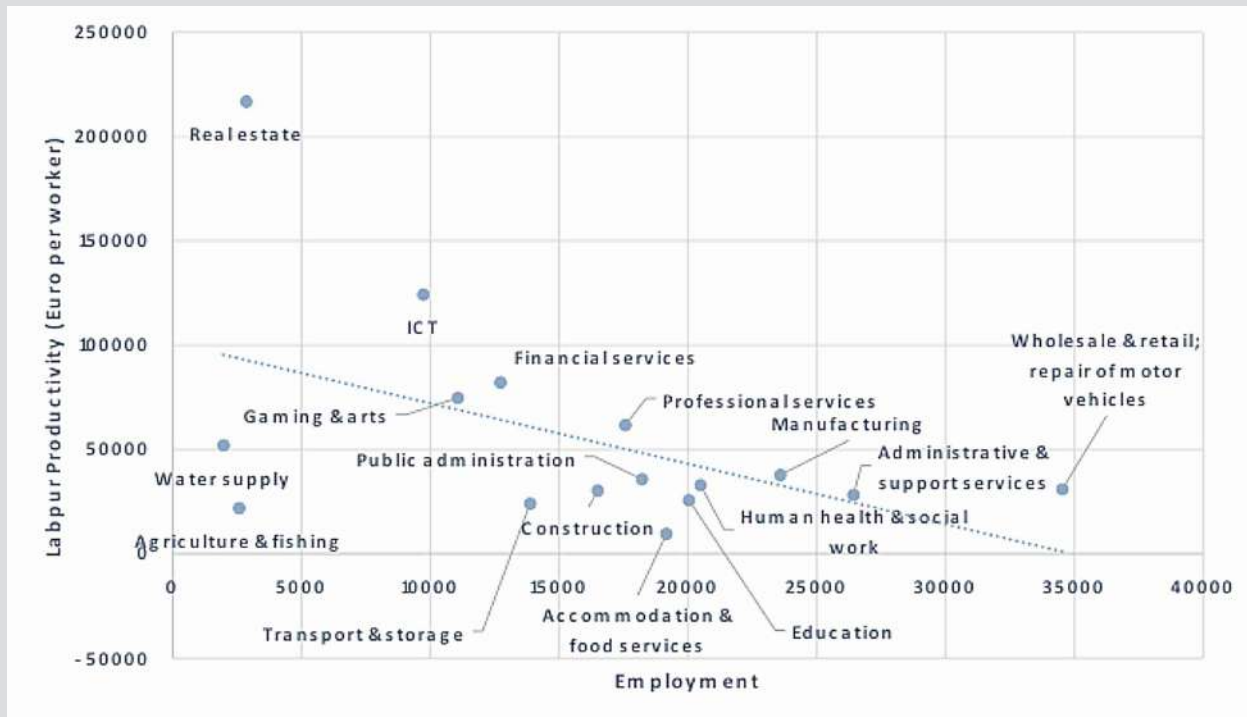
COVID-19 had on these specific sectors, with the onset of the pandemic and ensuing containment measures hitting transportation particularly hard, while effectively grinding the tourism and catering sectors to a halt. Nonetheless, it is still worth mentioning that while in 2019 transportation and storage recorded medium levels of productivity relative to other sectors, accommodation and food services reported the second-lowest level of labour productivity in Malta, albeit with a 15.0% level of growth between 2010 and 2019.

We now take a deeper look at sectoral productivity by analysing variations based on the size of the workforce. This relationship is depicted in [Figure 3.15](#) for the year 2020, with [Figure 3.16](#) grouping each sector according to whether they are high or low in employment and productivity.

As shown below, as expected there is a weakly-negative correlation between the size of the workforce and productivity, with leaner sectors like ICT, gaming and financial services having higher levels of productivity relative to larger sectors like wholesale and retail and manufacturing, although it is important to reiterate that this correlation is not particularly strong.

Nonetheless, what the diagram does suggest is that certain labor-intensive sectors with large workforces have struggled to generate higher levels of value-added, pointing towards the need for further digitization and investment in innovative technologies in sectors like wholesale and retail and manufacturing. On the other hand, sectors like ICT, real estate, gaming and financial services have successfully managed to generate significant value-added from a comparatively-smaller workforce, reflecting the booming nature of economic activity within these sectors.

Figure 3.15: Real labour productivity and employment, 2020



Source: Eurostat, 2022; Author's calculations

Figure 3.16: Sectoral classification by real labour productivity and employment, 2020

		Labour Productivity	
		Low	High
Employment	Low	Agriculture & fisheries; Transport	Water supply; ICT; Financial services; Real estate; Gaming & arts
	High	Manufacturing; Construction; Wholesale & retail; Accommodation & food; Administration; Public administration; Education; Human health	Professional services

Source: Eurostat, 2022; Author's calculations

3.4.2 Total Factor Productivity

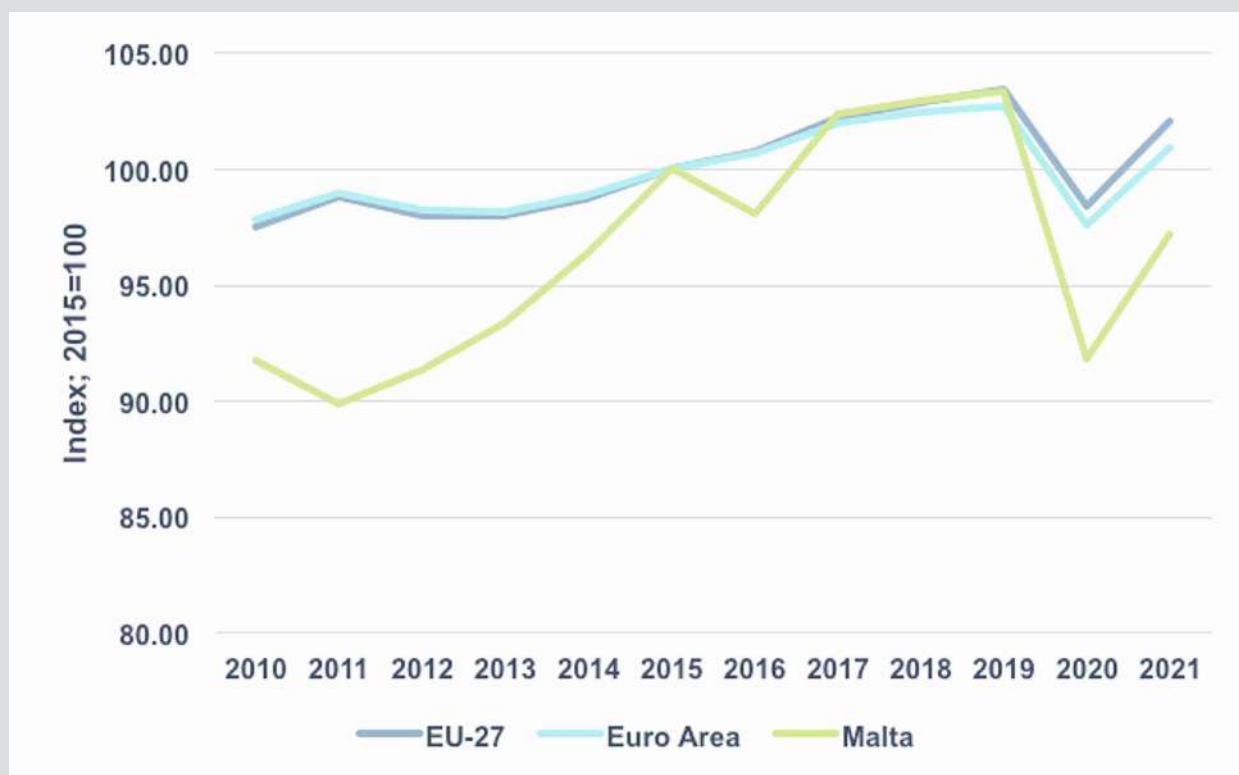
We shall now analyse a different yet complementary metric, namely Total Factor Productivity (TFP), which captures aggregate productivity across both factors of production, namely labour and capital. This indicator will help to shed further light on Malta's productivity performance in recent years, both overall and across industries. [Figure 3.17](#) shows movements in TFP over the period 2010 to 2021.

As seen below, Malta's TFP has largely lagged behind that of the rest of the EU and Euro Area countries, although we can observe convergence in TFP between 2011 and 2015/17, such that over the period 2017 to 2019 Malta's TFP briefly matched that of the other European countries. Nevertheless, following the onset of COVID-19 Malta's TFP dropped sharply, far more than the EU and Euro Area averages, although there was a rebounding of sorts in 2021, albeit not enough to return to either pre-COVID levels or indeed the other countries. Nonetheless, over the period under

review Malta's TFP grew by almost 6 percentage points, higher than the EU and Euro Area averages of 4.7% and 3.2% respectively.

We now dig a little deeper to understand the key industries that contributed towards Malta's TFP growth in recent years. [Table 3.8](#) provides a sectoral breakdown of TFP growth over a selection of industries based on data availability. As seen below, the highest level of TFP growth between 2010-2019 was recorded within the professional services sector, followed by accommodation and food services and construction. When considering that the latter two sectors have relatively low levels of labour productivity, as seen earlier in [Table 3.5](#), these results show that at least within these sectors there has been a concerted effort to drive productivity upwards, fueled in part by investment in capital stock.

Figure 3.17: Total Factor Productivity, 2010-2021



Source: KLEMS, 2022

Table 3.8: Total Factor Productivity growth in Malta by sector

	2015	2016	2017	2018	2019	Average Growth, 2010-2019
Manufacturing	-1.1	-1.8	9.5	4.0	0.2	2.2
Water supply	20.3	-9.4	-1.3	3.3	5.9	0.5
Construction	7.9	-0.5	19.4	5.4	3.8	4.3
Wholesale and retail trade	11.7	-13.6	11.0	1.8	-0.1	4.0
Transportation and storage	10.6	3.6	4.5	-2.3	-1.3	2.2
Accommodation and food services	10.1	-1.3	15.0	3.2	-1.7	5.0
Professional services	14.8	8.8	9.9	8.8	-0.1	7.7
Administration	19.0	-22.1	-37.9	6.3	3.9	-0.3
Public administration	-	-	2.9	0.8	0.6	0.9
Education	-	-	0.4	-1.9	-5.3	-2.0
Health and social work	-	-	1.3	-0.2	1.4	1.2
Gaming and Arts	-4.5	-34.1	2.8	-32.1	-10.5	-6.6

Source: KLEMS, 2022

3.5 RDI and productivity

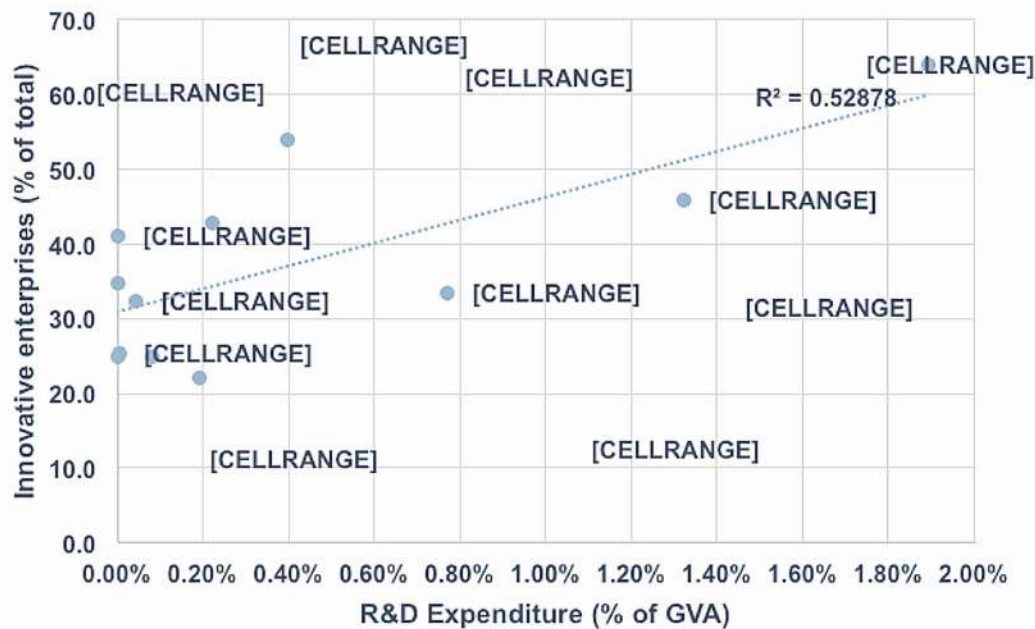
We conclude this section by analysing the extent to which business expenditure on research and development is correlated with innovation, and in turn the extent of productivity within each sector of the Maltese economy. This will assist us in understanding the intrinsic linkages between R&D, innovation and productivity, although it is important to note that such relationships are likely to be more long-term and dynamic in nature than the short-term, static correlations depicted in this section.

In the first instance, we consider the relationship between R&D spending and innovation, to understand whether expenditure on research in Malta translates into higher innovative activities. The results are shown in Figure 3.18, where BERD within each sector is plotted against the proportion of enterprises in each sector that can be classified as being 'innovative'. As seen below, there is a clear, positive correlation between R&D expenditure and innovation. Indeed,

as shown in Figure 3.19, the overwhelming majority of sectors are either classified as being 'low R&D spending, low innovation' (relative to the national aggregate) or in turn 'high R&D spending, high innovation', which underscores the importance of R&D to foster innovation within businesses.

We now analyse the extent to which innovation relates to labour productivity within each sector, to understand whether such innovative activities translate into tangible business benefits in terms of improved levels of output per worker. The results are shown in Figure 3.20, where we plot sectoral innovation against real labour productivity. As seen below, yet again we observe a clear, positive correlation between innovation and labour productivity, underscoring the role played by innovative activities in fostering higher levels of productivity among workers. These results may serve to counter the leading barrier to innovation cited in the CIS, namely that innovation is not a business

Figure 3.18: BERD and innovative enterprises



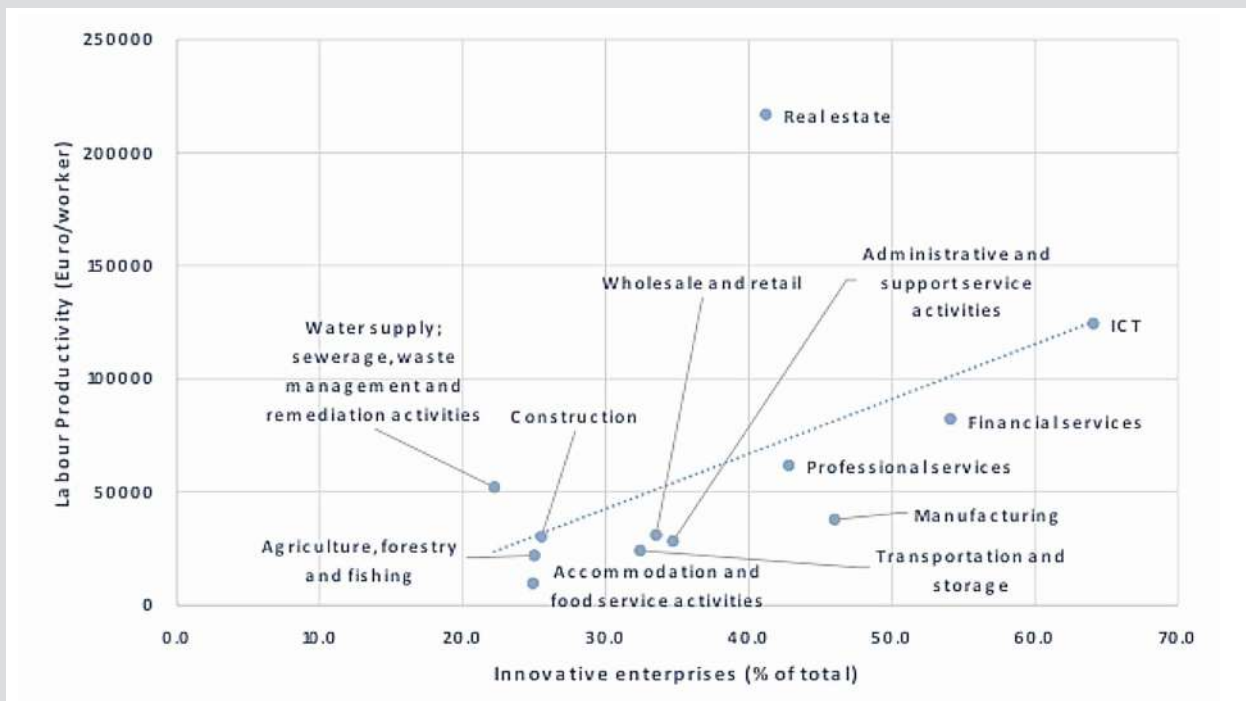
Source: Eurostat, 2018; 2022

Figure 3.19: Sectoral classification by R&D expenditure and innovation

		Innovation	
		Low	High
R&D Expenditure	Low	Agriculture & fisheries; Water supply; Construction; Transport; Accommodation & food; Administration & support services	Real estate
	High	Wholesale & retail	Manufacturing; ICT; Financial services; Professional services

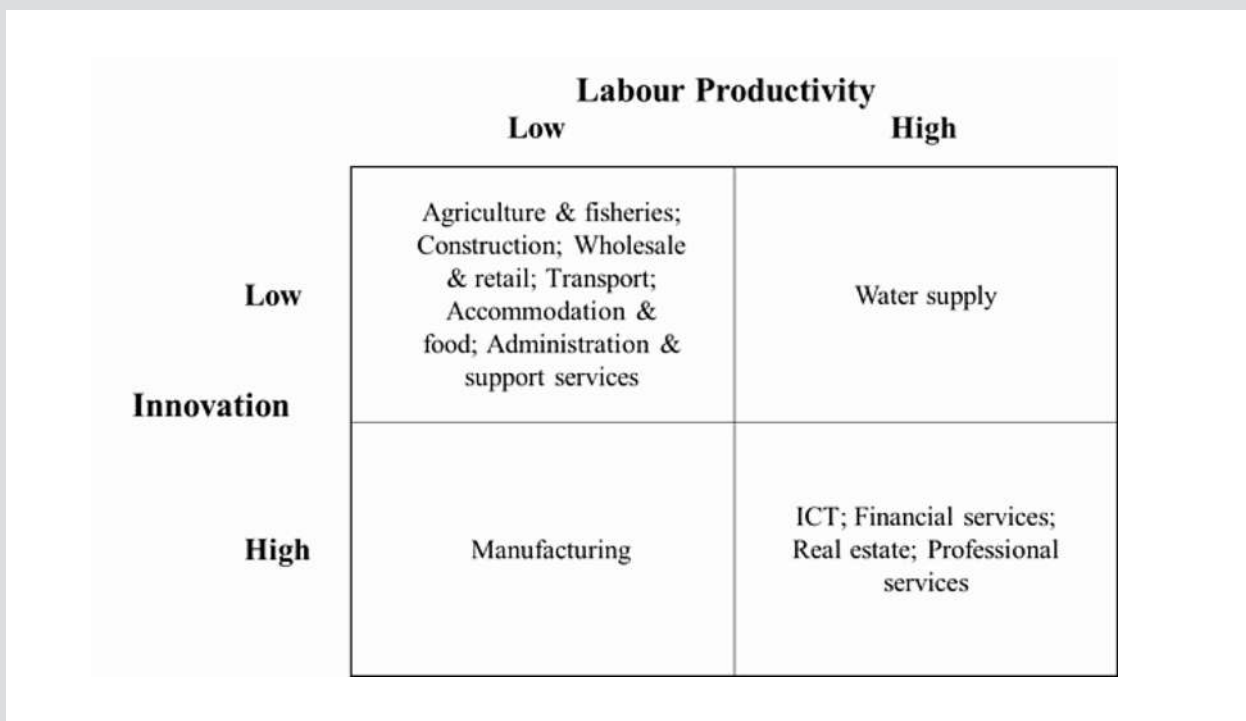
Source: Author's calculations

Figure 3.20: Innovative enterprises and labour productivity



Source: Eurostat, 2018; 2022

Figure 3.21: Sectoral classification by innovation and labour productivity



Source: Author's calculations

priority, since these results suggest that there is a clear business case for pursuing innovative investments in terms of higher productivity, which in turn may help to improve the enterprise's competitiveness (incidentally, this would also assuage the second leading barrier to innovation, namely high levels of competition). As seen from [Figure 3.21](#), once again most enterprises can either be classified as 'low innovation, low productivity', or 'high innovation, high productivity'. A notable exception is the manufacturing sector, with high levels of innovation and yet low levels of productivity.

This indicates that within this sector, innovation is not being translated into tangible efficiency gains, which implies that a change in approach is required with regard to R&D spending in manufacturing to direct it towards smarter uses that have a material impact on business processes or products.

4. A survey of the literature on the drivers of RDI with a focus on the Maltese economy

4. A SURVEY OF THE LITERATURE ON THE DRIVERS OF RDI WITH A FOCUS ON THE MALTESE ECONOMY

A country's well-being is measured, in large part, by its ability to produce a larger output of goods and services. If an economy grows by more than its population, the average per capita income, and the central measure of citizens' well-being, will rise. Therefore it is not surprising that the quest for economic growth has taken a central stage in policy making.

4.1 Introduction

Productivity has been identified as the most important factor for attaining economic growth. Productivity is broadly understood as a country's ability to produce given a set of human and physical capital: the higher this ability, the more productive a country is. Larger productivity is thus economically beneficial for society as it implies that more output can be attained with fewer resources. Formally, productivity growth is defined as the residual growth in GDP that is not explained by growth in either labour or capital (Solow, 1957).

Given the key role of productivity on economic growth, numerous theoretical and empirical papers have attempted to identify the main driver(s) of productivity growth. Currently, there is universal consensus on RDI (research, development, and innovation) being a central driver for productivity growth (e.g., Griliches, 1978; Aghion et al., 1998, Bloom et al., 2019).

RDI can be broadly defined as efforts undertaken by private and public sector entities with the purpose of developing new methods of production (including the delivery of goods and services), or the creation of entirely new products (Rodríguez-Pose & Crescenzi, 2008). The consensus regarding the importance of RDI on productivity, empirical work has not focused on whether such a channel exists but, rather, under which circumstances the channel is stronger

(e.g., Bloom et al., 2019). In what follows, we synthesise the literature with a focus on highlighting several aspects of the RDI-productivity relationship that can be of particular relevance to the Maltese economy.

4.2 Understanding the process of innovation

The size of the economy depends not only on the number of factors of productions deployed, be it land, human resources, and capital, but also on innovation, as technology is the most important for their efficiency effects. The creation and diffusion of technology can help an economy build new sets of dynamic efficiencies that arise from competitive advantages gained through new knowledge, where networking and economies of scale intensify the innovative capacity of modern firms. In modern times, economies have undergone a comprehensive transformation from large-scale manufacturing to developing new technologies, sophisticated engineering, software innovations, and social networking. These innovations are characterised by increasing returns and scale economies that also have strong positive spill-overs and complementary effects on various sectors of the economy. In this way, innovation is part and parcel of the endogenous growth theory and long-run capital accumulation.

In a broad sense, innovation involves developing new processes, products, or organisational improvements for the industry. Innovation is a complex process with multiple dimensions (Sengupta, 2014). Some of the essential types of innovations are as follows:

1. technology-based innovation,
2. endogenous vs exogenous innovation,
3. innovation in selection mechanism in industry growth, and
4. innovation through technology consortium.

Starting with the first type of innovation, technology-based innovation refers to product innovation, industrial R&D initiatives, and technology transfer through imitation and improvement. Endogenous innovation refers to investment in innovation, and as with any investment project, there is an expected rate of return. In order to stimulate investment in innovation, the products are usually protected by patent laws. In contrast, another form of R&D is exogenous in nature. This is not driven by market incentives and is typically driven by academic and non-profit institutions that can nonetheless bring significant productivity gains to industry and the broader economy. The third and fourth type of innovation refers to the selection mechanism of firms, that is, the process of entry and exit of firms and the various factors influencing the entry and exit decisions. Entry and exit of firms can either be because of industry growth or policy instruments that support incentives for innovation growth. Examples include firms operating in the pharmaceutical industry, where patents incentivise firms to undertake R&D operations and knowledge diffusion.

4.2.1 Schumpeterian innovation

Schumpeterian innovation theory is built on three basic premises for industry growth: creative destruction, creative accumulation, and rejection of competitive market equilibria (Sengupta, 2014). All aspects emphasise the role of evolutionary growth and endogenous innovation. Today's world would be incomprehensible for someone born during the industrial revolution. What explains this transformation? The answers lie in market capitalism, which was the driving force behind the growth and

why firms were able to reap the benefits of innovation, namely realising the competitive advantage that can lead to lower unit production costs and improved product quality.

The reason for this change over the years lies not only in economic freedom, science, and technology but also in what the Austrian economist Joseph Schumpeter called creative destruction. The creative destruction mechanism refers to the process by which new sources of competitive advantage replace obsolete ones.

In Schumpeter's theory of innovation, the role of the entrepreneur is to exploit the disruptions or discontinuities that destroy existing sources of advantage. In this way, shocks in production serve to rejuvenate the economy and increase productivity as surviving firms adopt new technologies and upgrade their capital stock. In contrast, Porter (1990) in *The Competitive Advantage of Nations*, views competition as an evolutionary process. Firms gain a competitive advantage by recognising new markets or technologies and moving aggressively to exploit them. In the process, the institutional economic frameworks play an important role in helping firms innovate, invest, and undertake R&D activity. Indeed, according to this view, small countries can gain competitive advantages in international trade as long as they are rich in technological knowledge. Similarly, the World Economic Forum Report edited by Porter (2004) recognises three components in computing the Growth Competitiveness Index (GCI): infrastructure development, quality of public institutions, and the adoption of the best practice technology of the world.

In a recent publication by Aghion, Antonin and Bunel (2021), the authors constructed an index of creative destruction by averaging the rate of firm formation and the rate of firm destruction. From data covering 587 regions in seventeen European countries between 2012 and 2016, the authors find that average annual growth in GDP per capita during this period was greater in regions where average creative destruction was more remarkable. This complements the descriptive analysis by Haltiwanger and Miranda (2013), which shows that new firms in the US create

many new jobs, many of which disappear. Those that survive create more jobs and therefore grow larger. Aghion, Antonin and Bunel (2021) also find that the American counties with the highest rates of job creation and job destruction, on average, were the counties that produced the newest patents between 1985 and 2010, has a correlation of 0.46, which is considered to be strong. Probably this is because young firms are most likely to create and destroy the most jobs (Akcigit and Kerr, 2018).

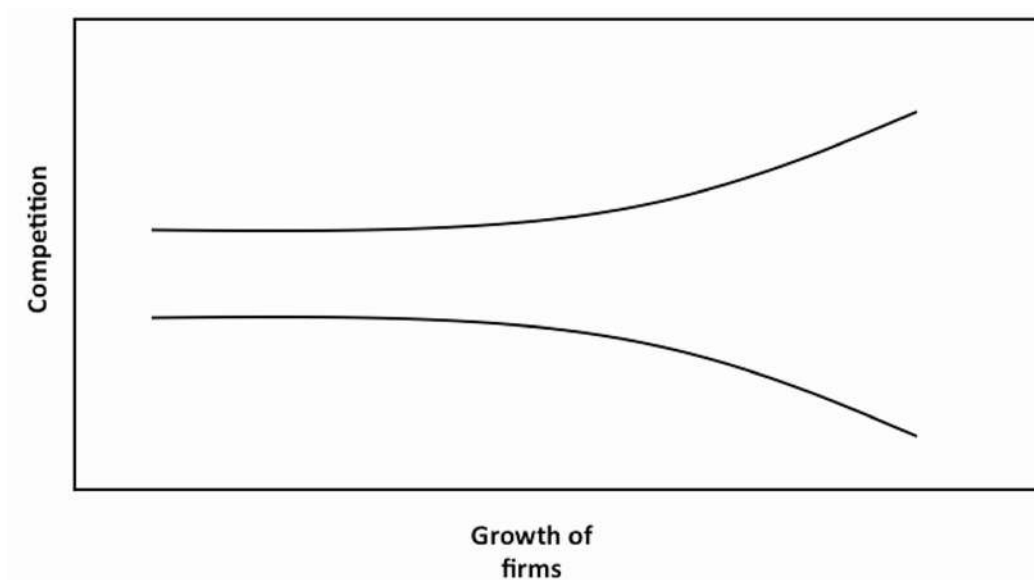
Aghion, Antonin and Bunel (2021) argue that there are three elements to how creative destruction stimulates economic growth. The first element is path-dependent, as today's innovation is built on the knowledge accumulated over the past years. Second, innovators are motivated by the opportunity to gain monopoly power to protect economic rents, thereby spurring further investment and hence economic activity. Third, while economic rents are necessary to attract innovators, early innovators must not use their rents to hamper new innovation, so competition policy should protect new entrants from incumbents. Aghion et al. (2009) demonstrate that once controlling for the endogeneity of entry of firms, firm entry affects the incentives to innovate in incumbent firms. That is, the threat of technologically advanced market entry spurs innovation in sectors close to the technological frontier but discourages innovation in laggard sectors, where the threat reduces incumbents' expected rents from innovating. At this point, it is worth pointing out that the destructive component of innovations has increased relative to the size of the creative component, as the new technologies often create products that are close substitutes for those they replace (Komlos, 2016). Consequently, it is contended that the contribution of recent innovations to GDP is likely to be skewed upwards.

Building on the link between creative destruction and economic growth, another important aspect to consider is the relationship between competition and creative destruction and innovation. The link between competition and creative destruction has been the subject of extensive empirical debate, as empirical observations differ from theoretical predictions. A distinct theoretical prediction of the Schumpeterian growth model is that under *laissez-faire*, strong growth

is expected when the business-stealing effect associated with creative destruction dominates the intertemporal transfer of knowledge from current to future innovators. Conversely, growth is expected to be insufficient when knowledge transfer dominates creative destruction. In this regard, the Schumpeterian model predicts a negative relationship between competition and growth; more competition lowers the economic returns from innovation and thus discourages entrepreneurs from investing in innovation. However, Blundell et al. (1995, 1999), using firm-level data in the UK, cast doubt on this prediction: they found a positive correlation between competition and innovation/growth.

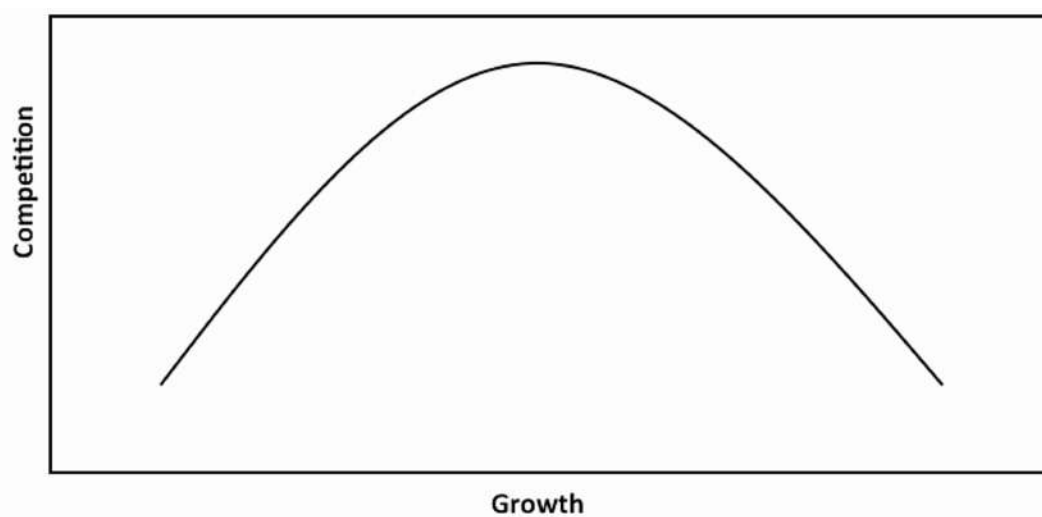
How can this divergence between theory and empirical findings be explained? Aghion (1997) explains this culprit by postulating that there are two types of companies. First, there are the so-called frontier firms, i.e., firms close to the current technological frontier in their industry. These firms are ordinarily first-movers, active and making significant profits even before innovating. Second, there are what we call the laggard firms, i.e., firms well below the current technological frontier. These enterprises make modest profits and try to keep up with the current technology frontier. Both the frontier and laggard firms react differently to innovation. Given a higher level of competition in their sector, firms close to the technological frontier will innovate more to avoid competition, while firms far from the technological frontier and trying to catch up will do so by discouraging competition and consequently less innovation (see Figures 4.1 and 4.2). Overall, the impact of competition on innovation and productivity growth is an inverted U, where competition discourages lagging firms from innovating (negative discouraging effect) but encourages neck-and-neck firms to innovate (positive escape competition effect). This was empirically confirmed by Aghion et al. (2005, 2009) using panel data.

Figure 4.1: Competition, growth, and distance to frontier



Source: Adopted from Aghion (2017)

Figure 4.2: Competition and growth: the inverted-U relationship



Source: Adopted from Aghion (2017)

The overall effect of creative destruction is complex, as while it spurs innovation and productivity in frontier companies, it kills weaker firms. Consequently, a trade-off exists between creative destruction and basic security for investment. Excessive creative destruction could discourage companies from conducting R&D without policies protecting their investments. Creative destruction can also have important implications for income inequality, as excessive job destruction, job insecurity and instability could lead to greater inequality (Blundell et al., 2021) which would be counterproductive. Practically this is because some workers receive efficiency wages and other market-clearing wages, reflecting the dual market structure of leaders and laggards.

The discussion presented above shows that competition policy in relation to innovation and creative destruction is a crucial economic framework that influences both the forms of creative destruction and the effects that creative destruction can have on society. While competition policy can bring about creative destruction, for example by removing restrictions that prevent new firms from entering, either through mergers between incumbents, by dominant incumbents restricting small market players, or by dominant firms restricting other abusive practices, but it can also help protect economic rents of incumbents. As an example, Aghion et al. (2009) and Aghion, Howitt and Prantl (2015) argue that patent protection and product market competition complement each other in promoting innovation. Intuitively, competition reduces the monopoly rents of non-innovating neck-and-neck firms, while patent protection is likely to increase the monopoly rents of innovating neck-and-neck firms. This perspective contrasts significantly with Romer (1990), who viewed competition as always detrimental to innovation and growth, and Boldrin and Levine (2008) who hold that patent protection is always detrimental to innovation and growth in their model where competition is good for growth.

The examples of creative destruction are numerous. At the onset of the Great Depression, the heavy industry, shipbuilding, and coal mining were in distress, but this was accompanied by rapid growth in automobile manufacturing, aerospace, consumer

goods, and new materials such as rayon and plastics. After stagflation and the oil crisis of the 1970s, jobs in manufacturing and the public sector became less attractive while the financial and real estate sectors boomed. This was accompanied by a rise in home ownership. In the 1990s, the technology sector boomed, while jobs in arts, entertainment, and leisure soared. Consumers spent a lot of money on computers, mobile phones, and internet connections.

Meanwhile, the long decline in manufacturing employment continued. After the 2008 Great Recession, the technology sector continued to expand, and so did businesses like discount stores, accommodation and food services and arts and entertainment. Additionally, smartphones and social media have reshaped customer relationships, and Covid-19 has accelerated pharmaceuticals, e-commerce, high-tech manufacturing, housewares, renewables, fintech and digital entertainment. The acceleration of existing trends related to digitisation and automation is expected to continue, shaping growth and welfare.

4.2.2 Creative accumulation

Building on Schumpeter's theory of innovation patterns in industry, Breschi, Malerba and Orsenigo (2000) propose that another innovation pattern involves creative accumulation, where innovations are taken forward by firms that were previously innovative: this is called deepening. This is in sharp contrast to creative destruction, where innovations are introduced by firms that have not previously innovated: this is known as widening. Therefore, the accumulation process refers to the implementation of new combinations that occur over time, e.g., by developing a new source of supply, establishing new firms, or changing the production function. Breschi, Malerba and Orsenigo (2000) further note that creative accumulation, as opposed to creative destruction, correlates positively with the concentration ratio of the top four patenting firms and the stability of the hierarchy of innovators, and negatively with the proportion of patent applications by firms that applying for the first time in a given period ⁵.

⁵ The hierarchy of innovators is measured by the Spearman rank correlation coefficient between the hierarchies of firms patenting in the 1978-85 period and firms patenting in the 1986-91 period. The proportion of patent applications is the percentage share of patent applications by firms applying for the first time in a given technological class in the period 1986-91 over the total patent applications in the same period.

4.2.3 Schumpeter's five types of innovation

Schumpeterian creative accumulation includes five basic types of innovation, which are discussed in detail by Andersen (2011). In general, the Oslo Manual identifies four types of innovations: (a) product innovation, (b) process innovation, (c) organisational innovations, and (d) marketing innovations (OECD/Eurostat, 2018). This classification seems to appeal to some of Schumpeter's ideas, only missing the innovation of input supply.

The types of RDI can thus vary widely. For example, some RDI may be focused on improving the internal operation of companies (also known as 'process innovation') whereas other RDI efforts may be directed towards improving firms' output offerings (also known as 'product innovation'). Government

policies directed at increasing RDI would have to consider which types of RDI efforts are more likely to produce productivity increases.

In the case of Europe, for example, evidence suggests that product innovation generates increases in productivity across several EU member states, whereas process innovation almost does not matter for productivity growth (Griffith et al., 2006). On the other hand, Hall et al. (2019) find that both matter with process innovation playing a more important role. In sum, the evidence is not conclusive about which type of innovation should be favoured. The main consideration of the literature for the case of Malta is that, to the extent that RDI policies will be carried out by considering these aspects, these policies should be made on a case-by-case basis: certain sectors may benefit more from one type of innovation whereas others might benefit from the other type.

Table 4.1: Schumpeter's five types of innovation

Product innovation	A new type of product or service is added to the existing system requiring a new production routine and also a change in consumption network.
Process innovation	A new technology for an existing product, requiring changes in input and output qualities.
Organisational innovation	Economies of scope and scale involving changes in business organisation and strategies for new market structures. For example, it includes the reorganisation related to the creation or destruction of a price cartel.
Market innovation	A product that previously has been used routinely by one group of consumers is introduced into the consumption routines of a qualitative different group of users or different countries. For example, it includes changes in market structure involving globalisation of trade, such as variants of iPhone introduced by Apple.
Input innovation	A new raw material or a new intermediate good is introduced into the economic system, e.g., software development. This may frequently involve the opening up of new sources of supply.

Source: Andersen, 2009 and Sengupta, 2014

4.3 Drivers of innovation

4.3.1 Government intervention

Given the public good nature of RDI explained earlier, much of the literature has focused on evaluating the effectiveness of the different types of government interventions as RDI facilitators. These policies can be grouped into tax incentives, grants, and human capital initiatives (Van Reenen, 2020). These first two groups are discussed below, whilst the third policy grouping is discussed in greater detail within [section 4.3.2](#).

Tax Incentives

There is a consensus in the literature that tax incentives significantly increase RDI levels (and hence productivity). The evidence spans cross-country data (e.g., Bloom, Griffith, and Van Reenen 2002), cross-state data (e.g., Wilson 2009) as well as within-country (micro-level) data (e.g., Rao, 2016). Two elements would need to be kept in mind for the case of Malta. First, tax incentives would need to be carefully designed so as to ensure (as much as possible) that RDI increases do not result from the mere accounting reallocation of expenses (e.g., Akcigit, Baslandze, and Stantcheva 2017; Bloom and Griffith 2005; Moretti and Wilson 2017; Wilson 2009). Second, tax credits would need to be ingenious in order to generate sharp incentives while complying with EU harmonisation rules.

Grants

Incentives to generate RDI can be provided to universities and research centres. The advantage of grants is that they can be directed more precisely toward RDI activities that are most likely to generate spill overs, and least likely to be carried out by firms (Van Reenen, 2020). In larger economies, this policy may be more practical given the ample number of non-profit institutions with the proper knowledge (universities, think tanks, etc.) to carry out these research activities (e.g., Jacob and Lefgren, 2011).

Research grants can be made viable by crafting guidelines so that their impact on industry and practitioners is greater. For example, research shows that the impact of research publications resulting

from grants does not generate large impacts on RDI (as measured by patents; see, for example Azoulay, Zivin, et al., 2019). If grants are, for example, designed to ensure a robust private-public collaboration (e.g., grants conditional on RDI being implemented at specific firms or industries), the RDI impact generated by grant incentives will be amplified. Indeed, grants have been shown to have important returns to RDI. For example, across OECD countries, Moretti, Steinwender, and Van Reenen (2019) show that direct government spending (through grants) is as cost-effective as tax incentives as a tool to incentivize RDI (and thus productivity and growth).

4.3.2 The importance of human capital accumulation

One challenge with government incentives aimed at increasing RDI is that if the supply of human capital that is trained to carry out RDI is inelastic, RDI incentives will be used to pay for the price premium generated in the labour market for skilled labourers or institutions (able to carry out RDI, e.g., Goolsbee; 1998). One way to reduce the potential inelastic supply of RDI is to expand the market by providing incentives (e.g., grants) across EU participants (a point noted above).

Another mechanism is the use of selective relaxation of immigration policies (or tax incentives) for skilled labourers and/or institutions that can carry out such RDI activities. A selective immigration policy is potentially quite impactful given the numerous empirical studies documenting large effects (e.g., Kerr and Kerr, 2020; Hunt and Gauthier-Loiselle, 2010; Kerr and Lincoln, 2010; Bernstein et al., 2019; Hunt and Gauthier-Loiselle, 2010; Moser and San, 2019; Doran and Yoon, 2020; Moser, Voena, and Waldinger, 2014).

There is ample agreement in the literature that higher levels of human capital are conducive to more RDI and larger levels of productivity. Thus, government investments in human capital (e.g., provision of public education) are a natural policy to increase RDI. However, the effectiveness of these policies can be amplified if such government investments are focused

on disciplines (or industry-specific skills) where RDI is more likely to be impactful for the economy and where RDI is most likely to generate the largest spillovers, such as STEM fields (e.g., Autor, Goldin, and Katz, 2020; Van Reenen, 2011). One challenge with this type of policy is that it is 'leaky': once locally trained, talent can migrate elsewhere.

4.3.3 Competition and internationalisation

An open question in the literature is the extent to which the level of competition affects RDI. This factor is particularly critical given the progressive opening of economies to world trade. In the case of large economies, commercial liberalisation, albeit important, may not expand markets as much as it is the case for small economies. In contrast, in the case of Malta, the internationalisation of markets generates a massive expansion of the potential market and, also, of competition. On the one hand, larger levels of competition can increase innovation (i.e., a monopolist that has no competitive pressure has no incentive to innovate; Arrow, 1962). On the other hand, the market power conferred by less competition provides the proper incentive for innovators to act (Schumpeter, 1942). While ambiguous in principle, empirical work to date has, by and large, found that competition increases innovation (Bloom et al. 2019; Grossman and Helpman, 1991; Shu and Steinwender, 2018; Atkin, Khandelwal, and Osman 2017; Bloom et al. 2014; Blundell, Griffith, and Van Reenen 1999).

Therefore, this evidence, would put an economy like Malta in an advantageous position to promote RDI. Progressive opening to international commerce, however, should be carefully thought out by taking into account the factors that were previously mentioned (selective choice of industries/clusters, focalized tax/grant incentives and tailored human capital policies) as well as other longer terms objectives such as sustainability (e.g., Halme, Korpela, 2014) and environmental preservation (e.g., Ashford, 2000).

4.3.4 Innovation clusters

Regional hubs, rather than countries, have become increasingly important as key spatial units to drive innovation as the main source of economic growth (Cooke et al. 2015). This also applies to the European context, in which regions are the focus of industrial and technology policy (European Commission 2010, 2011; Boschma and Frenken 2011).

The empirical literature on the importance of innovation clusters can be categorised into two groups. Work in the first category has examined the impact of innovation on regional growth. It follows the technology gap approach, meaning that regions enjoy a comparative advantage as well as a temporary monopoly status until other regions have gained the ability to imitate the innovation (Verspagen, 1997; Fagerberg and Verspagen, 1996, 2002; Sala-i-Martin, 1996). In this framework, innovation is seen as driving growth disparities between regions, while imitation serves to reduce economic disparities.

Another strand of literature recognises that the innovation process depends on the technological and economic performances of each region or local economic system. Therefore, innovation is related to the cluster structure of the economy, i.e., in terms of the relationships and flows connecting the different stakeholders and parts of the innovation system themselves (Cooke, 1997; Crescenzi, 2005; Cooke et al., 2015). Two important factors contributing to regional innovativeness are the ability to absorb available knowledge and translate it into (endogenous) economic growth and human capital. The latter is even often introduced in the empirical literature together with innovation as a determinant of regional growth (Crescenzi 2005; Crescenzi and Rodriguez-Pose 2011).

There is a long tradition of studies linking agglomerations of economic activity to geographic regions. This is mainly because agglomeration economies improve interpersonal relationships, thereby facilitating the transfer of tacit knowledge and thus innovation and growth (Zucker et al., 1994; Almeida & Kogut 1999; Balconi, et al., 2004; Singh 2005; Breschi & Lissoni 2009).

Agglomeration is also associated with urbanisation externalities, meaning that regions with high urban population densities facilitate knowledge transfer (Rodríguez-Pose and Crescenzi, 2008). Indeed, the empirical literature shows that geographic proximity is important for knowledge transfer and regional growth (Chapman and Meliciani 2012; Meliciani, 2016) and hence transport infrastructure that can facilitate economic cohesion (Crescenzi and Rodríguez-Pose, 2012). Economies of scale at the local level can play an important role in explaining the existence of clusters between regions (Henderson & Thisse, 2004). Such increasing returns are usually divided into purely technological and financial externalities (Krugman, 1991). The former type of technological externalities is related to knowledge transfer, while the latter is due to market-mediated mechanisms related to the availability of factor inputs such as labour force quality and primary and intermediate inputs.

Several factors explain knowledge spill over. In a survey, Audretsch and Feldman (2004) found that the two most important factors are location and proximity. Jaffe (1989), who introduced spatial context to test the existence of geographically mediated externalities, argues that knowledge is embodied in individuals and can only be transferred to others through contact (Von Hippel, 1994). It should however be noted that this statement does not take into account the recent innovations in workplace communication technology, especially post COVID-19, that may to an extent, have reduced the importance of spatial factors for knowledge spill overs. Several empirical works have attempted to find a direct relationship between knowledge spill overs rather than a general sign of local externalities; examples are Acs et al. (1994), Audrestsch and Feldman (1996), Audretsch and Stephan (1996) and Anselin et al. (1997). A recent set of studies attempted to analyse the main mechanisms and determinants of the process of innovative knowledge creation and dissemination in terms of temporal dynamics and geographic reach, using a full set of spatial econometric techniques. Examples cover local innovation activities and agglomeration for the US case (Varga et al., 2005) and for Europe (Bottazzi and Peri, 2003; Greunz, 2003; Moreno et al., 2005b).

All in all, the results show that technological spill overs can exist between and within regions. Moreno et al. (2005a) found that (i) the spill over effect increases the closer the region is to the cluster, (ii) the effects mainly occur across regions within a country rather than across nations, and finally, (iii) technological together with geographic proximity can play a role in defining the strength and scale of spill overs. In Europe, Moreno et al. (2006) show that specialised innovation clusters are growing, which is in sharp contrast to production clusters, which are shrinking due to delocalisation processes. Innovation clusters' localisation decisions are still heavily influenced by interactions with similar firms in the region; hence positive localisation externalities, mostly purely technological ones, are still at work. Therefore, bundling innovation activities by companies may still be seen as a sensible response to facilitate knowledge transfer and reap the benefits of economies of scale.

4.4 The role of research and development as an integral part of the process of innovation

R&D refers to any activity firms undertake to innovate and initiate new products and services. Without R&D, the company may not be able to bring new offerings to the market, which may eventually lead to the company failing or falling out of the competition. However, despite its potential economic benefits, R&D is not undertaken with the assumption that it will always pay off, at least not in the short term. Rather, R&D is typically implemented with an investment horizon of more than a few years and is complemented by a holistic, long-term strategy.

R&D is increasingly being integrated into the innovation policy debate. When firms are forced to innovate to survive and thrive, the immediate question is what government policies should be employed to stimulate industrial innovation and increase the potential capabilities of national innovation systems. At an EU level and in many OECD countries, the aim is to improve R&D activities overall.

There has been an increased recognition that more attention must be paid to this area. With Sustainable Development Goal 9 (SDG 9), countries have pledged to 'build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation'. In particular, Goal 9.5 calls on them to improve scientific research, improve the technological capabilities of industrial sectors in all countries, especially developing countries, encourage innovation, and significantly increase the number of researchers and public and private R&D expenditure. The two indicators used by countries to monitor this target are, (i) the R&D expenditure as a proportion of GDP, and, (ii) researchers (in full-time equivalent) per 1 million inhabitants.

In the EU, innovation policy is closely linked to other EU policies such as employment, competitiveness, environment, industry, and energy.

The role of innovation is widely recognised as important, especially in relation to R&D. However, compared to other advanced countries such as the US and Japan, the EU spends less on R&D as a percentage of GDP, and there is still a significant brain drain effect, causing the best researchers and innovators to leave the EU for more favourable conditions a less fragmented and innovation-friendly environment (European Parliament, n.d.).

The EU developed the concept of an Innovation Union, launched in 2010, which aims to: (i) make the EU a world-class science performer; (ii) remove barriers to innovation such as expensive patenting, market fragmentation, slow standard-setting and skills shortages that currently prevent ideas from getting to market quickly; and (iii) revolutionising collaboration between the public and private sectors, notably through the implementation of European Innovation Partnerships (EIPs) between the EU institutions, national and regional authorities and companies (European Commission, n.d.-b). Various tools have been put in place to measure and monitor innovation across the EU. For example, the Innovation Union Scoreboard and the Regional Innovation Scoreboard. In addition, the Commission has prepared a strategy to strengthen European standardisation (COM (2011) 0315), highlighting the need to improve

the way standards are set in the interest of long-term competitiveness of the EU industry.

Another Europe 2020 flagship initiative was the EU's 2014-2020 research and innovation funding programme, with an almost €80 billion budget. Horizon 2020 was the first programme to integrate research and innovation (European Parliament, n.d.). Horizon Europe has superseded the programme (European Commission, n.d.-a).

The new programme is tackling climate change, helping achieve the United Nations Sustainable Development Goals and boosting the EU's competitiveness and growth.

It facilitates collaboration and strengthens the impact of research and innovation in developing, supporting, and implementing EU policies while tackling global challenges. It supports the creation and better dissemination of excellent knowledge and technologies. It creates jobs, fully engages the EU talent pool, boosts economic growth, boosts industrial competitiveness, and maximises investment impact within a strengthened European Research Area. Due to the coronavirus pandemic, the Commission presented amended proposals to allow additional funding from the Next Generation EU (NGEU) recovery instrument to flow to Horizon Europe.

Cohesion policy also focuses on research and innovation. In more developed regions, at least 80% of European Regional Development Fund funding is allocated at national level to innovation, with priorities on a low-carbon economy and competitive SMEs (European Parliament, n.d.).

To stimulate private sector investment and R&D-related proposals, the Commission, in cooperation with the European Investment Bank Group, launched the InnovFin EU Finance for Innovators joint initiative. This initiative aims to facilitate and accelerate access to finance for innovative businesses and other innovative entities in Europe, from the smallest to the largest companies. InnovFin offers loans, guarantees and equity-type funding according to the specificities and needs of the innovators. Funding is either directly or through a financial intermediary,

usually a bank or fund. InnovFin is available in all eligible sectors in the EU Member States and Associated Countries (InnovFin, n.d.).

In addition, the European Institute of Innovation and Technology (EIT) was established in 2008, whose overall mission is to promote sustainable economic growth and competitiveness in the EU by strengthening the innovative capacity of the Member States and the Union. The EIT achieves its goals mainly through its knowledge and innovation Communities, which bring together more than 2,000 partners from business, research, and education.

The Commission also has a twenty-member High-Level Group of Innovators established under the EU Horizon programme. It has a budget of €10.1 billion to support game-changing innovations throughout the lifecycle from early-stage research to proof of concept, technology transfer, and the financing and scale-up of start-ups and SMEs. The strategy and implementation of the EIC are steered by the EIC Board, which has independent members appointed from the world of innovation (entrepreneurs, researchers, investors, corporates, and others from the innovation ecosystem) (European Parliament, n.d.).

4.5 RDI in the context of the Maltese Economy

In the Maltese context, it is relevant to qualify what we mean by research and innovation. This is not to say that research and innovation do not and cannot play a key role in enhancing productivity.

It is important to note that what we would like to emphasise is that in Malta the scale of research and innovation can never compare with that carried out in larger jurisdictions where large companies and research institutions can conduct research and innovation requiring huge financial outlays as well as technical/academic resources unavailable in the Maltese Islands. That said, it is relevant to note the strong interest shown by researchers in particular for MCST's FUSION R&I: Research Excellence Programme. This programme which is launched once a year provides financial support for the early-stage

development of innovative projects, through a bottom-up approach. All scientific research areas are being considered under this programme. FUSION is composed of two main programmes, namely the Commercialisation Voucher Programme (CVP) and the Technology Development Programme (TDP).

Both programmes are essentially intended to provide the vital mentoring and financial support required by researchers and technologists to lift their ideas off the ground and take them to market. The CVP aims at improving the development and commercialisation potential of 18 innovative research ideas, whereas the TDP supports the actual development of innovative projects proposed by public entities and industrial players ⁶.

Examples of TDP projects completed include: Development of a Low-Wearing Novel Metal on Metal Hip Joint Prosthesis for a Longer Lifespan; Development of Hydro-Energy Storage System for Offshore Multi-purpose Floating Platforms; and Accurate Cancer Screening Tests. The financial support may run to several thousands of euro and following the successful completion of the projects under CVP, 12 projects were awarded funding for through TDP during 2019 for a total of funding of almost €2.8M.

For innovation to happen, however, it is not always necessary to conduct expensive research and, on their part, small and medium-sized enterprises (SMEs) can be just as resourceful in and on their part small and medium-sized enterprises (SMEs) can be just as resourceful in innovation particularly in streamlining work processes and by developing new technologies (albeit somewhat limited) that help increase productivity.

Smaller businesses are particularly prevalent in the services sector where innovation in work flows and practices can make a huge difference to the future prospects of the business. SMEs will no doubt continue to play an ever more important role in our economy of the EU. However, they are not a homogenous group of enterprises and it is essential to classify SMEs in accordance with their research and innovation requirements and potential. A single definition of SMEs would be meaningless in this

⁶ <https://mcst.gov.mt/wp-content/uploads/2020/10/MCST-Annual-Report-2019.pdf>

context and would make it impossible to set out practical recommendations.

4.5.1 Definition of SMEs

According to Grech (2019) the definition of small and medium-sized enterprises (SMEs) follows that adopted in Eurostat's Structural Business Statistics (SBS) database - which is solely based on the number of employees working with a firm. Data on the number of enterprises are sourced from the National Statistics Office (NSO) business register which covers all economic sectors. As described in Grech (ibid.) SMEs constituted 99.9% of all firms, with the vast majority, 97.3%, being micro firms employing less than 10 persons. Small firms, employing between 10 and 49 workers, accounted for 2.2% of all enterprises, while 0.5% of all firms were medium-sized.

Micro enterprises account for 35% of the economy's total value added (in terms of Malta's enterprise economy), as against 25% for small firms and 20% each for medium and large firms. However, this pattern differs by sub-sector. Construction and real estate are dominated by micro firms (that account for nearly 55% of value added in the sector), while large firms account for a negligible share. The latter can also be said of the wholesale and retail sector, though within this sector micro and small firms account for 43% and 36% respectively. In the accommodation and food services sector, medium-sized firms account for approximately 40% of value added (double the proportion observed in other sub-sectors); while in the transport sub-sector, it is large firms that account for this share (Grech, ibid.).

It is pertinent to highlight that Maltese SMEs operating in the business economy sector generated nearly two-thirds of all growth in value-added and half of the increase in employment. This is a healthy development as a growing dependence on many SMEs is making the Maltese economy more resilient to external shocks. This is of particular relevance given the current crisis in Ukraine. Also, SMEs are more flexible and can be better agents for innovation than larger firms, and are quite capable of introducing new processes and products.

Three Categories of SMEs

Against this backdrop, we propose distinguishing three categories of SMEs insofar as innovation is concerned:

Small enterprises having a high technological capacity

Enterprises in this category have a well-established research and innovation capacity and they supply or make use of technology. Such enterprises are in the minority. An encouraging number of SMEs in this category are involved in research projects funded by the EU through MCST.

Enterprises in this category face a major disadvantage from the point of view of their size and their resources; they have difficulty in competing on an equal footing with larger companies.

Enterprises having unused capacity for innovation

Enterprises in this category may be described as enterprises valuing innovation, which, whilst lacking the characteristics of the first category of SMEs, are nonetheless able to develop new products with technological input. We are talking here generally of SMEs which are the most highly developed from a technological standpoint in their sectors.

SMEs in this second category are able to define their research and innovation requirements but they have to outsource research work as they lack adequate research and innovation capacity.

This category of SMEs plays a crucial role in disseminating technological innovations to their fellow SMEs which have a smaller capacity and in adapting such innovations.

Enterprises in the second category frequently manage to find solutions (the provision of suitable aid through agencies like Malta Enterprise), but they are increasingly coming up against problems and technological requirements which cannot be easily dealt with locally.

Enterprises making use of the final products of research and innovation

Enterprises in this category merely make use of the products of technological research. As discussed in Chapter 3, these SMEs represent the vast majority of SMEs in the Maltese economy and are solely interested in the final products of research and innovation. Such enterprises do not invest in risky or long-term technological projects and they lack the means to identify their own technological requirements.

In the absence of intensive awareness-promotion, preparation and backup, these enterprises will never have access to the technological opportunities yielded by research and innovation programmes.

The above classification illustrates different requirements in respect of research and innovation as well as funding requirements. This classification needs to consider a further factor, namely the fact that Malta-based SMEs are situated in the periphery of the EU and this in our view is a disadvantage insofar as research and innovation capacity is concerned. Reducing technological disparities in the EU is of particular relevance to Malta-based firms, especially SMEs.

4.5.2 Role of SMEs in the process of innovation

SMEs have a fundamental role to play in the process of innovation, especially in digitalisation and SMEs need specific help to enable them to gain access to research and technological innovation. In our view, SMEs need to be more receptive in terms of uptake to any form of support provided through Malta Enterprise and other entities which helps them to improve their technological input.

Existing measures providing technological stimuli for SMEs seem to be having some effect though in our view it is too early to quantify the benefits of these measures on productivity. Also, one may consider 'exploratory awards' that provide SMEs with financial assistance for putting together projects (location of

partners, market analyses and analysis of the opportunities for innovation, and feasibility studies); and (ii) cooperation across groups of SMEs which have little or no research capacity but common needs, to entrust research and innovation work to the University of Malta or MCAST laboratories or research centres abroad. Such cooperative research can be a valuable feature to support innovation and increase productivity.

It should be noted that the interest in innovation shown by SMEs and their readiness to respond will always depend on whether the schemes in existence match their specific requirements. This may not be so straightforward and the analysis in this report should shed some light on this. In our view, therefore, there needs to be a differentiated approach in regard to Malta-based SMEs with projects relating to innovative work practices featuring prominently in schemes/measures aimed at assisting investment in SMEs.

We consider funding for such innovation (targeted at innovative work practices) to be of vital importance since it primarily affects the most vulnerable SMEs, namely the SMEs which have an absolute need for specific assistance if they are to make use of innovation in their strategic planning. If no such assistance is forthcoming, there is a danger that the level of innovation carried out will not make any substantial difference in improving productivity.

The cooperative research and innovation approach is particularly appropriate to the second category of SMEs, i.e. enterprises that have the potential for research and innovation but where such potential is currently unutilised. A major part of the effort to support innovation, particularly in work practices should be concentrated on this category of SMEs. Only by adopting such an approach can progress be made in achieving the main objective, namely to make the Maltese economy more productive and competitive especially if Malta-based businesses are competing at the international level.

Above all, it is necessary to recognise the difficulties facing SMEs in the field of technological innovation. They still have to contend with many obstacles preventing them from taking steps to innovate their

businesses. Such difficulties include: inadequate access to information; difficulties in finding partners; time and financial constraints; and an inability to define innovation requirements and projects.

The only way in which SMEs can overcome these difficulties is through the provision of targeted technical and financial support for projects that help SMEs become more innovative in the workplace. In particular, this should relate to the process of developing and introducing something new. This may be a process, product, or service, and innovation, and the goal of innovation should be to improve or optimise actions, results or revenue. What is important in our view is that workplace innovation is beneficial, no matter how big or small it is. Making small changes can be an important first step, especially if the business is in a slow-to-change environment. Small changes can in fact lead to significant improvements and such improvements can serve as an inspiration for bigger changes and projects.

Workplace innovation may not appear as something extraordinary but it actually is. It refers to workplace practices and cultures that enable employees at all levels to use their knowledge, competencies and creativity to the full. It builds workplaces in which people come to work to undertake their functional tasks in the most effective way possible and to improve the organisation. Evidence shows that workplace innovation leads to significant and sustainable improvements in both organisational performance and employee engagement and well-being.

For a detailed explanation of workplace innovation and definitions, we suggest referring to the European Commission's report titled "Workplace Innovation: Concepts and Indicators"⁷. Also relevant to note is that the Commission supports workplace innovation through three projects, two of which could be of interest to local businesses.

These are INNovaSouth and Start at Best.

The first is targeted at Southern European SME's and is intended to embrace entrepreneurial culture while increasing SME's market resilience and

competitiveness by providing services and financial support for innovative workplace solutions. One of their tools is the online manual of good practices. This manual aims to inspire entrepreneurs to find simple, immediate and innovative solutions to increase employees' motivation and productivity.

INNovaSouth can also provide local SMEs with an €8,000 voucher to be spent on workplace innovation services, goods, tools and best practices. This helps local entrepreneurs adopt these solutions for increased employee productivity.

Start at Best contributes to new European-led workplace innovation among SMEs. Its innovative attitude draws from the startups, and financial grants are on offer through open calls for proposals, adding to workplace innovation in EU countries, especially where the practice is less integrated. The problem with this scheme is that the budget provided is very small and very few enterprises can actually benefit. Of course, one needs to consider national aid schemes for startups such as the Business START which offers seed funding for startups.

The measure administered by Malta Enterprise is intended to support Small Start-up Undertakings that have a viable business concept and are in the early stage of its development. Initiatives that are deemed to be economically viable are supported through a grant of up to €25,000.

Another very relevant scheme administered by Malta Enterprise is the Business Re-Engineering and Transformation Scheme, the scope of which is for SMEs to realign their business activity, restructure their employees, product and/or service portfolio, optimise the use of technology and embrace green technology and practices. SME's with the drive to innovate can seek support from external advisors to assist them in carrying out significant changes that will enable them to accelerate development and improve market access. The aid is awarded in the form of a cash grant covering 50% of the costs incurred up to a maximum grant of €5,000 per advisory service per undertaking.

⁷ DocsRoom-European Commission (europa.eu)

4.5.3 The significance of Workplace Innovation

The previous section describes schemes that support workplace innovation in different settings. However, for such schemes to be successful, they need to be based on the following propositions⁸:

1. Workplace innovation must be a strategic choice and directly related to a firm's business model.
2. Categorising SMEs can be helpful to determine businesses that are more conducive to workplace innovation.
3. Achieving high performance is a high priority with positive impacts on working life and to the wider society.
4. Fair work is important since improved working conditions can help improve performance.
5. Leadership styles, culture, engagement and job satisfaction are largely determined by work organisation and the effectiveness of management.

Workplace practices based on research and evidence also help to improve performance, with job autonomy, teamwork, skills, and a flexible approach to work driven by employee involvement and empowerment. Innovation becomes the product of inclusive dialogue, experimentation and learning. Workplace innovation is the result of on-going efforts to combine all the above. Such an approach inspires employees to improve performance and become more creative.

Workplace innovation helps change organisations and is strongly associated with trust, accountability, creativity, coaching behaviours and emotional intelligence.

It should be stressed that workplace innovation is embedded in the economic growth policies of several countries, transforming the way that a growing number of businesses work across all sizes and sectors of the economy. Tangible economic and employee benefits at the enterprise level is also likely to have wider impacts on the labour market and economy.

Skills demand is enhanced because employers need individual workers to embrace wider technical functions and, critically, to enhance generic skills including problem-solving, communication and team working. Product and service quality are enhanced while the rate of innovation grows, thereby breaking out of the low-skills equilibrium trap. Hence, the benefits derived from workplace innovation are significant and extend beyond the confines of the business. At the same time, the cost of implementing workplace innovation in business including SMEs is not prohibitive. And yet, workplace innovation can still be described as research and innovation. It is certainly of relevance to a small economy like ours.

Researchers have accumulated a vast body of evidence relating to the impact of workplace innovation on productivity, quality, customer service, financial performance and a broad array of other business outcomes.

One of the most significant studies, the Employee Participation and Organisational Change (EPOC) survey of 6,000 workplaces in Europe, confirms that direct employee participation can have strong positive impacts on productivity, innovation and quality. Of firms that implemented semi-autonomous groups, 68% enjoyed reductions in costs, 87% reported reduced throughput times, 98% improved products and services, and 85% increased sales. SMEs also indicated that companies with workplace innovation initiatives achieve higher productivity and financial results compared with other firms.

In our view agencies like Malta Enterprise need to further promote and develop workplace innovation through advice, coaching and hands-on support to improve business performance, enhance capacity for innovation and create better jobs. Malta Enterprise already has an impressive list of scheme relevant to research and innovation aimed at SMEs as reproduced below:

1. The Access to Finance: Soft Loan is a financial instrument designed to support undertakings engaged in a manufacturing or service activity, accelerate their plans in establishing new products or entering a new geographic market,

⁸ Similar propositions are contained on the website of Workplace Innovation Europe. Workplace Innovation Europe helps organisations develop their workforces to their highest potential, empowering their people to achieve across a wide range of business indicators from productivity and innovation to employee engagement and wellbeing. Workplace Innovation Europe helps organisations develop their workforces to their highest potential, empowering their people to achieve across a wide range of business indicators from productivity and innovation to employee engagement and wellbeing.

addressing environmental concerns and digitise processes. Such undertakings may be supported through a soft loan covering part of the funding requirements of up to one million euro (1,000,000).

2. **Business Development:** This measure facilitates value added projects, including new business initiatives, expansions and transformation activities that shall contribute to the regional development of Malta. The scheme may support various activities such as the initial development phase of undertakings establishing an operational base in Malta, expansion projects, consolidation of activities and the reengineering of business processes. Support may be awarded in the form of tax credit or a cash grant.
3. **Business START** offers seed and growth funding for small start-ups. Start-ups undertakings that are still in their early development phase may receive an initial grant of up to ten thousand euro (€10,000) to help them develop their business proposal and undergo a feasibility study that will help them determine the feasibility of their business idea. Start-ups that present a viable business plan may receive additional support linked to full time employment which may reach up to €25,000 per quarter up to a maximum of €200,000.
4. **Business Re-engineering and Transformation Scheme:** The scope of the scheme is to support small and medium-sized enterprises (SMEs) to realign their business activity, restructure their employees, product and / or service portfolio, optimise the use of technology and embrace green technology and practices. SME's with a vision to develop can seek support from external advisors to assist them in carrying out significant changes that will enable them to accelerate development and improve market access.

The aid shall be awarded in the form of a cash grant covering 50% of the costs incurred up to a maximum grant of €5,000 per advisory

service per undertaking. Beneficiaries may only be supported through this measure once in any 18-month period.

5. **EUREKA** supports the development of rapidly marketable innovative products, processes and services across all technological sectors through collaborative Industrial Research or Experimental Development projects up to 36 months in duration involving partners from Malta and other EUREKA countries.
6. **Exploring Research Grant Scheme:** Through this measure, Malta Enterprise aims to support businesses carrying out feasibility studies to determine the technical and commercial challenges and carrying out preliminary activities that will enable businesses to make more knowledgeable decisions in the development of the intended research and development project. The Corporation may support the implementation of a feasibility study with a cash grant of up to fifty thousand euro (€50,000) which shall cover a percentage of the eligible costs depending the size of the undertaking.
7. **Innovation Aid for SMEs** aims to facilitate the creation of Business Research Partnership between SMEs and Research Knowledge-Dissemination Organisations to carry out projects leading to product, process and organisational innovation. Through this measure funding can be provided for the secondment of a highly qualified person, access to innovation advisory provided by the Research Organisation and innovation support services identified through the collaboration. The scheme will facilitate access to expertise and the generating of new knowledge and aims to accelerate innovation, enhance business performance and drive competitive advantage.
8. **Invest-Support for Initial Investment Projects** aims to sustain the regional industrial and economic development of Malta by facilitating initial investments through the setting up

of new establishments, expansion of existing facilities and diversification of existing businesses. Support may be awarded through loan guarantees, interest rate subsidies, cash grants and tax credits. The support is aimed at facilitating access to funding and accelerating the return on investment.

9. Micro Invest encourages undertakings (including Start-ups, family businesses and self-employed) to invest in their business, so as to innovate, expand and develop their operations. Undertakings benefitting from this measure will be supported through a tax credit calculated as a percentage of eligible expenditure, which also covers increased in wage costs.
10. The Patent Box Deduction Rules, 2019 establishes a fiscal regime for income arising from patents, similar intellectual property (IP) Rights and copyrighted software. The rules additionally provide that small companies may utilise the patent box rules on income from any intellectual property based on an invention that could be patented. A tax payer qualifying for the Patent Box deduction will be entitled to deduct a percentage of its income from taxable income. This deduction will be adjusted depending on the percentage resulting from dividing the qualifying IP expenditure by the total expenditure related to the particular IP.
11. Qualifying Employment in Innovation and Creativity: This measure facilitates employment of non-residents in roles which are currently not addressed by the local labour market by temporarily easing the tax expenses incurred by such individuals through a fiscal incentive.
12. Research and Development 2020: The aim of this incentive is to assist Industrial Research and Experimental Development activities required by industry for the acquisition of knowledge leading to the development of innovative products and solutions. The

measure also encourages cooperation between undertakings by providing additional assistance for Industrial Research and/or Experimental Development projects.

13. Start-up Finance 2020: The aim of this measure is to support Small Start-up Undertakings that demonstrate a viable business concept and that exhibit commitment to expand and further develop their economic activity. Malta Enterprise may provide support up to four hundred thousand euro (€400,000) which may be increased to a maximum of eight hundred thousand euro (€800,000) if the start-up is an innovative enterprise. In our view such schemes can stimulate and engage leaders, managers and front-line employees to innovate, expand and develop business enterprise. We are also of the view that Malta Enterprise could work with the University of Malta and/or MCAST to capture and analyse leading practice, and to translate it into practical tools and learning resources.

The objective should always be to create innovative workplaces that enable people at every level of the organisation to use and develop their full range of skills, knowledge, experience and creativity. Also, relevant would be peer-to-peer exchanges of knowledge, experience and ideas as these can be one of the most powerful forces for workplace innovation and improvement. It is also in line with the idea of collaboration across SMEs as referred to earlier.

The benefits of workplace innovation cannot be stressed enough. However, we caution that they are only fully realised when workplace innovation practices run throughout the entire company including individual learning and discretion, self-managed teams, open and fluid organisational structures, delegated decision-making, simplified administrative procedures, a coaching style of line management, regular opportunities for reflection, learning and improvement, high involvement innovation, entrepreneurial behaviour at all levels, and employee representation in strategic decisions.

Transformative changes in performance and working life can be achieved when senior teams, line managers and employee representatives share a common understanding of workplace innovation and a commitment to making it happen.

4.6 The role of Industry 4.0 and Industry 5.0

Technological advances over the last few decades have enabled us to remotely store terabytes of information and transmit it worldwide in minutes. In addition, machines and devices can use computer memory, and sensor capabilities to the point where machines can be connected and operated via voice, touch, or programming prompts. The industrial revolution did not end in the computer age but continued to develop (Figure 4.3). In fact, the revolution is entering a new phase, and computers will play an active role in tomorrow's industry.

Throughout history, there have been various industrial revolutions. The first industrial revolution followed the period of proto-industrialisation. It began in the late 18th-early 19th century when the primary means of production shifted from labour to machine power. Fuel sources such as steam and coal made machinery more practical, allowing for increased productivity, productive capacity, and economic growth. The second industrial revolution, which took place between 1870 and 1914, brought massive technological advances in the industry that helped the emergence of new energy sources such as electricity, gas and oil. This period led to the development of the demand for steel, chemical synthesis, and communication methods such as the telegraph and telephone, as well as the use of cars. In the second half of the 20th century, we saw the emergence of the third industrial revolution through nuclear power and the rise of electronics, telecommunications and computers.

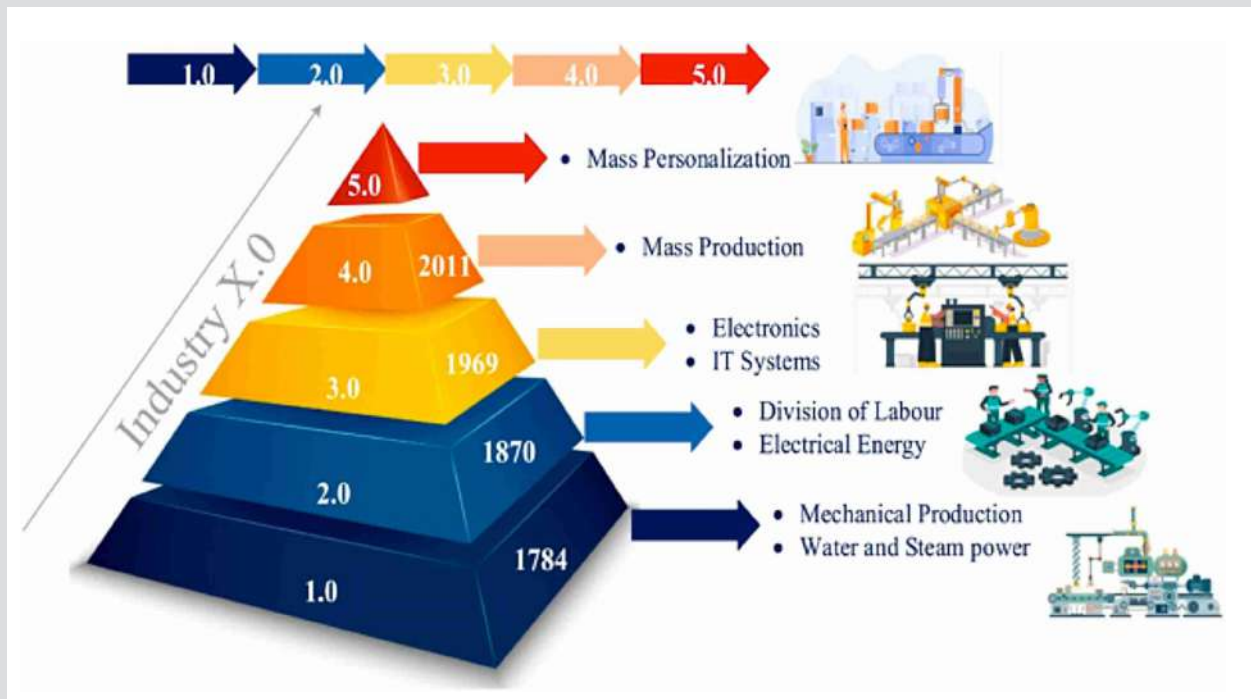
Industry 4.0 is the term used in the modern manufacturing world to denote the fourth industrial revolution, characterised by the widespread deployment of cyber-physical systems, where computer-based algorithms operate devices. The

main principle of Industry 4.0 is to make the manufacturing industry 'smart' by interconnecting machines and devices that can control each other throughout the life cycle (Xu, 2020). This revolution includes a high degree of automation, in which machines can essentially control themselves in many ways through the Internet of Things (IoT) technologies. Other characteristics of Industry 4.0 are cloud technology, the importance of big data and technology platforms that use artificial intelligence. The main goal is to maximise productivity and achieve mass production using new technologies (Lu, 2017; Echchakoui and Barka, 2020). There are generally recognised benefits associated with Industry 4.0. The first is automation, which could contribute to improved scalability in manufacturing companies, both in terms of faster production and opening up new markets on a global scale.

Industry 4.0 has been deeply integrated into the supply chain across all stages, from how manufacturers source their raw materials to how they deliver their finished products. For example, manufacturers can now easily share their production data with other suppliers in order to plan and better schedule the deliveries of intermediate goods. When manufacturers are immediately notified of delivery delays, there is less wasted time or money. With such data, manufacturers can better predict shipments to ship finished goods at just the right time to meet consumer demand. Indeed, blockchain is emerging as a key technology to enable transparency in supply chains. Another example relates to embedded sensors and connected machines that can use data analysis to help manufacturers examine historical trends, identify patterns, and make better decisions. By looking at data trends, smart factories can produce customised goods that meet individual customer needs more cost-effectively, derive sales margins, and follow an effective marketing strategy.

While Industry 4.0 is still evolving, some argue that the next revolution is already taking shape. Here, evolution is designed to use the creativity of human experts working in tandem with efficient, intelligent, and precise machines (ElFar et al., 2021).

Figure 4.3: Illustration of industrial evolution



Source: Maddikunta et al., 2022

The key difference is that Industry 4.0 focuses on IoT-enabled smart devices, while Industry 5.0 focuses on bringing the human mind into the industrial framework with machines (Nahavandi, 2019). Industry 5.0 is already underway, proving that some companies are not immediately laying off their workforce and becoming fully computerised. In this sense, the concept of Industry 5.0 alleviates some of the apprehensions that some manufacturers have expressed regarding the digitisation and automation process. Namely, cognitive computing will lead to massive job losses and technological unemployment. On the contrary, the unemployment caused by Industry 4.0 could be offset by a shrinking labour force and new green and digital jobs (O'Grady and Gownder, 2022).

5. Methodology

5. METHODOLOGY

This section sets out the methodological approach adopted as part of this report in order to elicit primary data relevant to the research, development, and innovation landscape within the Maltese Islands.

5.1 Approach

This section will set out the methodological approach adopted as part of this report in order to elicit primary data relevant to the research, development, and innovation landscape within the Maltese Islands. The broad intention is to complement the analysis conducted earlier based on secondary data as well as the insights gleaned from the literature review using primary data gathered from interviews and focus groups. More specifically, the research aims to achieve the following objectives:

1. To understand the current state of play with regard to RDI across several key industries in Malta, both in terms of current activities, planned activities and perceptions.
2. To understand the key enablers and barriers to RDI in Malta, including internal, external and regulatory factors.
3. To derive meaningful insights into the initiatives that can be taken at the sectoral level in order to drive RDI forward and enhance Malta's productivity and competitiveness.

As mentioned, the study will employ a combination of methods for the collection of primary data, namely interviews and focus groups. Interviews have become ubiquitous as a research tool across a variety of disciplines (Roulston & Choi, 2018), employing a variety of techniques and questioning styles depending on the information sought out. The scope is typically more nuanced than standard survey-based methods,

since in interviews it is not simply the responses that need to be gathered, but also the context within which the respondent is replying to the questions, while avoiding the imposition of the researcher's own biases and assumptions (Britten, 1995). Therefore, respondents must also be allowed to express their views in order to add depth to their responses or to, in some cases, move beyond the confines of the interview's structure.

On the other hand, a focus group consists of a small carefully curated and moderated group of individuals selected by the researcher in order to discuss and respond to one or more questions, typically centred around a specific topic or area of inquiry (Litosseliti, 2003). The use of focus groups originated within the sociology sector where such groups were being utilised for market research, which later branched out to other fields including the medical field (Smithson, 2000). Participants within the group would be able to freely interact and discuss the questions asked and would influence each other, which would ensure that further conversation would ensue freely within a group, resulting in more data being collected. The ultimate goal of both the interviews and the focus groups, as set out by Noor (2008), is to assist in 'understanding the subjectivity of social phenomena'.

5.2 Structure

The starting point for the organisation of the individual interviews and focus group sessions were six key thematic areas, consisting of the four groups included under Eurostat's classification for high-tech manufacturing and industry and knowledge-intensive

Table 5.1: Sectoral group areas by Eurostat RDI classification

Area	Eurostat RDI Classification	Sectors
1	High-tech knowledge intensive manufacturing activities	Pharmaceuticals; Optical equipment and electronics
2	Low to medium technology intensive manufacturing activities	Manufacture of toys and plastic; Furniture; Currency
3	High tech knowledge intensive services	Telecommunications; Information technology; Programming and consultancy services
4	Knowledge-intensive service activities	Finance, insurance, and advisory services; Marketing; Gaming; Digital games; Accommodation and food services; Aviation and transportation
5	RDI stakeholders	University of Malta; MCAST; MCST; Malta Enterprise; Ministry of Education, Sport, Youth, Research, and Innovation
6	Gozo stakeholders	GRDA; Gozo Chamber of Commerce; Ministry of Gozo

Source: Authors' Own Contribution

services, based on NACE (Rev. 2) codes (Eurostat, 2022), together with two additional groupings for RDI stakeholders and Gozo, reflecting the unique realities of the Maltese RDI landscape, particularly when it comes to Gozo. These areas are listed below in [Table 5.1](#), together with their respective sectors and/or a selection of putative stakeholders.

A series of semi-structured interviews were held with representatives from each of the first four areas, representing the various sectoral groupings, as listed above, covering a wide spectrum of key business players within these industries. Interviews were selected as the data collection tool of choice in these cases since this would allow respondents to express their views in a secure, open environment while also overcoming any trepidation related to possible commercial sensitivity, which is particularly salient within the scope of research, development, and innovation. In addition, the use of semi-structured

interviews allowed researchers to derive comparable responses for certain key questions across different firms and sectors, facilitating comparative analysis, while at the same time allowing respondents to go beyond the confines of the questions and fully express the rationale behind their choices, or their general views on the topic at hand.

In addition, for the final two sectoral grouping areas focus groups were set up and held for the two stakeholder groupings identified in [Table 5.1](#), reflecting the relative sizes of each group in order to ensure that the discussion is as manageable and as informative as possible. A minimum of four participants were recruited for each focus group session, in order to strike a balance between eliciting a diverse range of opinions while at the same time ensuring that everyone is afforded the space and opportunity to express their views without excessive time restrictions. Each focus group lasted one hour,

and one of the authors involved in the writing of this report acted as a moderator within the focus groups, with a clear mandate to:

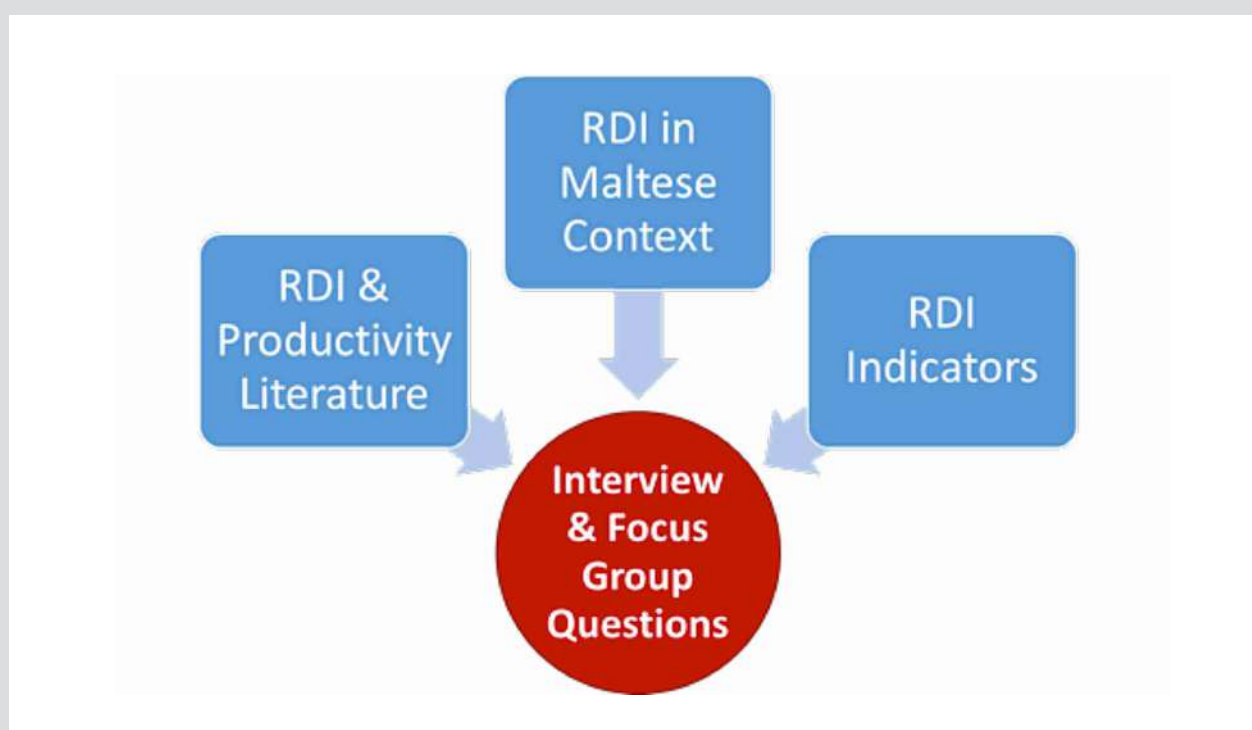
1. Introduce the topic at hand, and the scope of the report.
2. Ask a number of relevant questions.
3. Encourage active participation, interaction, and engagement across participants.

All sessions were recorded in order to facilitate the subsequent analysis, with all recordings stored on a secure, encrypted drive accessible only to the lead report authors. Participants involved in both the interviews and focus groups were targeted via purposive sampling (Tongco, 2007), which relies on non-probability sampling in order to select the right profile of participants based on experience and knowledge within the industry, as well as relevance to the subject matter, namely RDI in Malta.

The questions used in both the interviews and the focus groups were structured around the information derived from three key sources in this report, namely the literature review, the analysis of RDI within the Maltese context, and the quantitative analysis of RDI indicators for Malta, as shown in [Figure 5.1](#).

This three-pronged approach assisted in deriving the core questions related to enablers and barriers of RDI in Malta, including, amongst other factors, human capital, internationalisation, profitability, lack of funding, lack of internal finance, and competitive forces. A copy of the interview questions is provided in Appendix II of this report. Given the more fluid nature of the focus groups, the questions were more open in nature and aimed at generating discussion and debate among participants, although the line of questioning was similar to that reported in Appendix I. Respondents were asked to score the importance of each enabler or barrier from 1 to 10 in order to derive a 'score' for each sector that can be used for comparability purposes. Although there is significant

Figure 5.1: Key sources for focus group questions



Source: Authors' Own Contribution

variation across the different sectors in terms of characteristics and attitudes towards RDI, a common set of questions within this setting was deemed to be the most appropriate strategy for eliciting relevant information.

This is because having a common set of robust questions would assist in comparing the enablers, barriers, and readiness towards RDI across each of the relevant business focus areas while ensuring that each session contributes towards the common objectives set out in this report.

At the same time, the nature of the questions allowed for individual, tailored responses across each respondent based on their experiences in relation to RDI, allowing for a more bespoke development of ideas and policy recommendations given the unique realities of the sectors involved in the individual interviews. In cases where further information was required, follow-up questions were sent to respondents in order to elicit further insights into their responses. Similarly, during the focus groups, the moderator was instructed to encourage participants to actively discuss their points freely, as well as generate interactions across participants in order to develop a stronger set of findings.

This underlines the main reason why a qualitative approach was selected as the medium of choice for eliciting primary data, since it provides a structured yet flexible platform to facilitate a deeper dive into the state of RDI in Malta across various sectors and stakeholders, and thus a more meaningful discussion on the initiatives that can be taken in order to boost RDI in Malta over the coming years.

Following the completion of the interviews and focus group sessions, the qualitative data obtained was transcribed and analysed using thematic analysis (Braun & Clarke, 2006). The purpose of thematic analysis is to develop patterns of meaning ('themes') across a dataset that address a research question. Patterns are generated by the researcher through a rigorous process of data familiarisation, data coding, and theme development and revision. Therefore, through a systematic, iterative process, the myriad opinions and talking points that were raised during

the interviews and focus group sessions were organised, triangulated, and compiled under common themes, which in turn are linked to the key objectives of the research.

6. Key findings

6. KEY FINDINGS

This chapter presents the key findings obtained from the primary data gathered from the interviews and focus groups which had the overall aim of assessing the research, development, and innovation landscape within the Maltese Islands. As denoted in Chapter 5, this section aims to provide a sectoral perspective on the current state of play with respect to RDI in Malta and to highlight which are the key enablers and barriers to RDI, both at a sectoral, as well as a national level. The analysis put forward also acts as a foundation for the formulation of specific initiatives and recommendations aimed to drive RDI forward and enhance Malta's productivity and competitiveness which are presented in Chapter 7.

6.1 Tourism

Long considered to be a cornerstone of the Maltese economy, the tourism industry has gone from strength to strength in recent years. Although the COVID-19 pandemic dented this progress somewhat, post-pandemic recovery has been strong, and arrivals continue to grow.

Productivity-Enhancing RDI

Several initiatives are being taken in the tourism sector to enhance productivity. These initiatives are seeking to innovate the way hotels are run by providing new products and services with an emphasis also on green investments aimed at reducing energy costs while reducing carbon emissions at the same time. There is also a strong focus on monitoring developments not only in Malta but also abroad and in particular external ideas or technological developments for improved services in tourism. This is hugely important since it helps boost the sector's competitiveness. On their part most employees keep records of their good work practices or lessons learned, with the purpose to share these with other employees.

RDI to Boost Productivity

The rapidly changing environment and the need to identify new markets requires the hotel business to

innovate and enhance productivity. Other considerations such as knowledge and skills of existing workforce, forward-looking leadership, favourable government policy, availability of public funding, and keeping up with competition in Malta and abroad are less of a determining factor as driving forces for increased productivity.

Financing Issues

On the other hand, lack of internal finance, lack of external finance (credit or private equity) and uncertain market demand constitute the main reasons for factors limiting innovation in the tourism sector. High costs, lack of qualified employees within the organisation, lack of collaboration partners, difficulties in obtaining public grants or subsidies, lack of access to external knowledge, are a lesser challenge.

Insofar as what can be done at both the national and EU level in order to encourage greater R&D spending and innovation in the economy, the view is that this is not easily determined and requires in-depth research to provide a reply that is evidenced-based.

6.2 Information and Communications Technology (ICT)

The ICT sector incorporates various enterprises that are at the forefront of Malta's digital revolution, with the sector being one of the very few to record continued growth during the COVID-19 pandemic.

Continuous Investment in RDI

A key theme that emerged from the interviews conducted is the significant focus that these enterprises place on continually investing in RDI projects. These can take various forms, from large-scale EU-funded projects to investigate cutting-edge technologies across diverse applications, often in collaboration with research institutes like the University of Malta, to investments related to improving existing products, services and processes and the development of new products.

There is also a broad spectrum of projects when it comes to the nature of the research itself, with a small handful primarily focused on foundational knowledge and basic research that may lead to new product or services, while the majority of projects are more commercially minded with a clearer and altogether quicker pathway to market. One respondent cited the growing global drive towards digitization, which has become a policy target for many governments across the world, and which is at the heart of innovation within this sector, meaning that products and services must be aligned with this new reality and its various facets, including automation, Big Data, and the Internet of Things (IoT), all of which bring new opportunities as well as challenges, particularly within the local context.

Another theme that emerged from the interviews is the growing importance of RDI for the purposes of creating more sustainable and green products or services, with ESG (environmental, social and governance) issues cited as an emerging driver for businesses to innovate its products and indeed its processes. All respondents also mentioned that they actively monitor external ideas or technological developments within their respective field in terms

of new products, services, or processes, as part of the general work responsibilities of their staff members, with one respondent also mentioning that good practices and continuous improvement processes are formally recorded and documented by staff members as part of their drive for ISO certification in a variety of key areas.

RDI to Lead the Pack

A wide array of factors was mentioned by respondents as being the key drivers of RDI investment within their organisations. One of the most important factors cited in the interviews was the desire to compete both domestically and internationally, and in particular the role of RDI in helping these enterprises tap into new export markets abroad.

One respondent mentioned the growing global desire to adopt certain new technologies as an important driver for investment in RDI, since failure to do so would jeopardise competitiveness, whilst in turn being at the cutting-edge of technology enables one to compete with international players. Once again, the global trend towards greener and more sustainable products and services, fuelled by growing environmental awareness, was mentioned as a key development and catalyst for investment in related RDI projects.

On a related note, the role of Government policy was also mentioned as an enabler of RDI, since new policies may direct innovation towards certain directions in order to improve the lives of citizens, like for example the need for more secure communications, or greener transportation, which in some ways forces businesses to innovate in order to come in line with these policies. One respondent cautioned that Government may also contribute towards stifling innovation if it is inefficient in its operations or fails to recognise emerging opportunities. Another factor that was mentioned as an important driver of innovation is leadership within the organisation and their desire for continuous improvement and openness to new ideas and processes, alongside the skillset of the workforce in order to pursue research and participate in innovative projects.

Lack of Finance and People

Respondents were then asked to comment on the key barriers to RDI investment within their organisation. Although the responses received were varied, the most important theme that emerged from participants was the lack of available finance for RDI projects, both internally and externally. One respondent commented on the lack of internal finance, given the costs required to properly undertake research, with this issue being particularly pertinent for smaller businesses and start-ups. A related point mentioned was that this lack of finance makes it especially difficult for such businesses to attract the right pool of talent since they are unable to offer competitive salaries relative to other industries like gaming.

As for external financing, the focus of responses was on the very limited size of the private equity market in Malta, which penalises innovative start-ups and other potential companies. Respondents also mentioned that certain legislative measures that are currently in place locally stifle innovation, like for example capital gains tax requirements for start-up shareholders who have raised equity funding. Another important barrier to RDI mentioned by respondents is the lack of talent within the sector, which is a global issue rather than simply a local one, although remote working has helped to alleviate these pressures to some extent. Nonetheless, one respondent mentioned that this issue is likely to keep growing in the future, meaning that competition for talent will be more intense, thus necessitating a larger pool of STEM graduates in Malta. According to the respondent, STEM fields are perceived as being hard work locally, with little focus on the potential rewards and satisfaction arising from such a career choice, meaning that a concerted effort is required locally in order to change perceptions.

The role of public and research institutions was also raised by respondents. One respondent commented on the fact that the University of Malta tries to fulfil many roles, at the expense of one if its key remits, namely research, to the detriment of RDI in Malta. Another respondent mentioned that although there is always goodwill to collaborate on projects,

institutional support in Malta is limited, and that such collaborations typically would have to be undertaken within very specific parameters which may not be in line with commercial goals or timelines. Thus, there is scope for institutions like the University to rethink their approach towards collaborations, with a stronger focus on practical, results-based projects that can benefit local industry. On a broader level, the role of the public sector in incentivising RDI in Malta was mentioned, particularly in terms of its willingness to take more risks given the nature of such projects. One proposal was for Government to actively-invest in promising start-ups as an equity investor via the Malta Development Bank, similar to other countries in Europe and elsewhere like Slovenia, Estonia, and the UK. At EU level, one respondent mentioned the need to move away from set rules and procedures, and a greater focus on risk, with existing application procedures penalising smaller businesses in favour of large companies, and a greater budgetary allocation towards risky, albeit promising, ventures. This would assist in bridging the significant innovation gap that currently exists within the global ICT sector between the EU and countries like the US and China.

6.3 Financial services

The financial services sector has come a long way over the last few decades, maintaining its position as a leading sector of the Maltese economy and accounting for the lion's share of foreign direct investment (FDI) in Malta.

Start-Up RDI

A number of projects/investments are currently underway or planned in the financial services sector but mainly as new businesses. That said, increasing competition in the sectors helps boost productivity. The MFSA continuously receives proposals for new business to be established in Malta, several of which are likely to materialise in the following year. A number of projects have an innovative element, particularly with respect to the application of technology with investment in digitalisation and new financial products.

External ideas or technological developments in the local financial sector are continuously monitored by

the MFSA's Supervisory functions throughout their respective authorisation and supervisory processes. In addition, with the aim to build further supervisory capacity, in 2019, the MFSA had established a dedicated team within the Fintech Supervision (FS) function which is mandated to monitor, understand, and assess the developments and implications of the use of innovative technology and digital transformation occurring within the local financial sector and beyond.

RDI for Competitiveness

In achieving its mandate, the FS function is responsible for the MFSA's Innovation Facilitators, namely the Innovation Office and Regulatory Sandbox. These tools enable the industry to explore innovative technology-enabled solutions which materially support the provision of a financial service/s whilst providing the MFSA with the opportunity to understand and acquire knowledge on the latest technological development in the local financial market.

Insofar as factors facilitating innovation in the financial services sector, keeping up with competition in Malta and abroad, rapidly changing business environment, and the desire to identify new markets are cited as the more important factors. Lesser factors are knowledge and skills of existing workforce and favourable Government policy.

Global Uncertainties Hinder RDI

As for factors limiting innovation uncertain market demand and stiff competition were cited as the more important reasons. Lack of internal and external finance were also issues affecting innovation but surprisingly, lack of qualified employees within the organisation was not as important. Difficulties in obtaining public grants or subsidies were deemed more important.

The view on what can be done at both the national and EU level in order to encourage greater R&D spending and innovation in the economy is that in the financial services sector such spending should go to identify innovative technology-enabled solutions which materially support the provision of a financial services in the Maltese islands.

6.4 iGaming and digital games

The iGaming sector has emerged as one of the pillars of the Maltese economy, with the country developing into one of the world's premier centres for iGaming, attracting companies and talent from across the globe. In more recent years, iGaming has grown to encompass the development of digital games and e-sports, with a concerted effort made to cultivate this niche both through attractive incentives as well as the development of local talent via the University of Malta's Institute of Digital Games.

RDI for Competitiveness

When asked about their current RDI activities, respondents mentioned numerous examples of RDI projects that they are currently involved with in some capacity. This underlines, as mentioned by one respondent, the necessity of investment in RDI within the sector due to market saturation and maturation. Innovation is required in order to stand out and maintain a competitive edge, with technologies and/or concepts like augmented and virtual reality (AR/VR), the Metaverse, blockchain, and cryptocurrencies cited by respondents.

Another factor mentioned as fuelling innovation was rising compliance costs within the sector, with emphasis on automation and the use of Big Data in order to minimise human resource requirements and create efficiencies in order to reduce costs. Some respondents mentioned investment in AI in order to improve productivity, while others mentioned broader investments in process and skill enhancement in order to keep up with market dynamics. Another key area that was mentioned was RDI related to environment, social and governance (ESG) considerations, since this has emerged as a key area of focus for many organisations both due to customer requirements as well as reporting and compliance, necessitating the identification and tracking of specific indicators or KPIs.

The majority of respondents stated that their employees actively keep track of and document any good work practices or lessons learned, with the purpose of sharing them with other employees. Others mentioned that employees keep track of good practices related to forming project consortia and

writing up of successful project applications. One respondent mentioned having a dedicated team to monitor new developments within the sector, particularly in terms of innovative products, services, and processes, although for the most part respondents stated that this was part of the daily tasks of its workforce, given how important such active monitoring is for research and innovation.

RDI to Navigate a Dynamic Working Environment

A wide array of factors was mentioned by respondents as drivers of RDI within their organisations. Nonetheless, the one theme that consistently emerged from responses was the need for RDI in order to keep up and thrive within a rapidly changing and evolving global work environment, which is particularly pertinent within a sector like iGaming and Digital Games characterised by high levels of dynamism.

One respondent mentioned the need for RDI in order to stay ahead of the curve and competitive, while another stated that continuous investment in RDI is crucial to avoid falling behind and maintain a positive reputation, particularly in light of growing competition both domestically and abroad. Another factor that was mentioned by several respondents was the attitudes and openness of leadership within their organisation towards innovation and the culture that permeates. One respondent stressed that without a mentality of continuous improvement, the desire to explore novel ways of bettering products, services and processes would not exist, underscoring the importance of strong leadership. In addition, the skills and knowledge of the existing workforce was also mentioned as an important driver of innovation, given that these projects can at times be highly technical and thus requiring specialized research skills, with respondents also emphasizing the importance of investing in training in order to develop the capabilities of team members and their capacity to undertake research. The issue of costs and funding was also mentioned by a number of respondents, mainly in terms of the ability of RDI to streamline processes and optimize input usage, thus improving overall efficiency and profitability, with the flipside being that such investments entail significant costs, meaning that the availability of funding opportunities for RDI is an absolute necessity.

High Costs and Lack of Funds Shackle RDI

As expected, respondents mentioned various factors that hinder RDI within their organisation and indeed across the entire sector. One of the main themes that emerged from the responses is related to the high cost of conducting research, which can be burdensome for businesses particularly for smaller entities. One respondent further elaborated, stating that these high costs are also related to the high cost of living in Malta relative to the salaries offered for research/innovation positions, which makes it harder to attract top talent in innovative fields like AI and Deep Tech due to the prohibitively high living costs. This further exacerbates another important factor, namely the lack of available talent, since although respondents mentioned that their existing workforce is highly skilled, there are well-documented shortages of qualified individuals globally, making it ever harder to attract and retain such talent.

Another key theme that emerged is the lack of funding, which limits research capacity and innovation, with respondents mentioning a lack of internal financing and well as a lack of external finance from credit or private equity. In addition, competition and uncertain market demand were also mentioned as potential barriers to RDI, since market volatility may render it difficult to anticipate trends in consumer tastes or competitive forces, hence hindering the ability of businesses to plan their RDI projects accordingly, especially if the focus is more on short-term survival, which may lead to different priorities and goals given that RDI is more long-term in focus and potentially quite risky.

Respondents also had plenty to say in relation to public and research institutions within the Maltese Islands, and the role they play in cultivating RDI. Several participants called for increased incentives for cooperation between the private sector and high-level educational institutions such as the University of Malta, to better equip current and prospective employees and to leverage the expertise that is already present on the island for RDI. Others also stated that Malta should focus on 2-3 niche areas and plan its long-term R&I/D strategy and investment around those areas, rather than adopting a broader, generic approach, leveraging existing strengths and

research capacity (e.g., focus on world-class research centres/institutes already established at the University of Malta). Respondents also mentioned the need for tax incentives that encourage further investment in RDI, as well as improved access to wider international capital and accelerator support in order to mitigate a lack of funding. Finally, one respondent called for greater support for the development of Malta's esports and digital gaming ecosystem, given its significant potential and the strides already made in this regard.

6.5 Aviation

The aviation sector is crucial to the economic wellbeing of the Maltese Islands given the lack of road-based connectivity with other countries, coupled with its centrality to the success of the tourism industry. In addition, in recent years Malta has also managed to attract various leading international aviation companies to set up shop locally and operate across a variety of sectors, including the maintenance, repair and overhaul of fixed and rotary aircraft, R&D and back-office support, not to mention Malta's burgeoning role in aircraft registration.

RDI to Boost Efficiency

The biggest challenge in the aviation sector is competition and the continuous need to increase efficiency. Therefore, solutions such as outsourcing of passenger, baggage and cargo handling are deemed as the optimal choice. This affects service delivery and operational efficiencies leading to lower costs, increased productivity, and lower turnaround times. Whereas in the main no records of good work practices are kept and shared in the sector, the monitoring of external developments in the aviation sector is critical since the landscape of technological developments in aviation is very fast and dynamic. New technologies are offering unlimited opportunities. The challenge here is that financial solutions need to be found to support the aviation sector to fund technology-based solutions that boost efficiency and productivity.

Skills-Driven Innovation

Factors cited as facilitating innovation in the sector are knowledge and skills of existing workforce and

availability of finance. One factor that was also cited was employees' aptitude which recalls the relevance of research on workplace practices and how innovation and aptitudes can help improve productivity. The need to identify new markets is also deemed of some importance as is favourable Government policy.

Competition and Market Uncertainty

Regarding the factors that limit innovation in the aviation sector, these relate to the high level of competition and the uncertain market demand for routes in the airlines industry. Difficulties in finding collaborative partners is also cited. As far as what can be done at both the national and EU level in order to encourage greater R&D spending and innovation in the economy, a relevant issue to the sector is how to extend financial aid and support to critical entities that currently do not qualify for such financial aid. This is an EU-wide problem and falls under European Commission competence.

6.6 Manufacturing - pharmaceuticals and electronics

This diverse sector covers a broad range of business entities, although in the majority of cases the main players are all foreign-owned, multinational corporations.

International RDI Activity

Respondents were asked to comment on their RDI activities and projects, as well as the type of research undertaken within the company. What emerged from the interviews was decidedly mixed, with some admitting to a lack of ongoing RDI activities currently, while others mentioned that they are currently engaged in RDI activities internationally, in conjunction with global research institutions. These responses are not surprising given that as mentioned in previous chapters of this report, foreign-owned businesses in Malta typically house their research facilities elsewhere rather than domestically, meaning that RDI in Malta among such businesses would be relatively low. Nonetheless, all respondents expressed

a general openness to participate in RDI activities, particularly in relation to product and process improvement. In terms of those companies engaged in RDI projects, respondents mentioned a variety of activities including the development of new products as well as new methods of delivery for new and existing products, especially within the pharmaceuticals industry.

One respondent also mentioned innovation in marketing, with the focus being on illustrating the benefits of their products to end-users in order to boost revenues. Respondents were split on extent to which employees are required to document and keep records of any good work practices or lessons learned in line with workplace innovation, with those responding positively originating from the pharmaceuticals industry. Indeed, one respondent mentioned that they actively-encourage their employees to publish their work in journals and other peer-reviewed publications. Nonetheless, all respondents mentioned that they actively monitor external ideas or technological developments within their industry, as part of the general responsibilities of staff members employed within their respective companies.

Sustainability-Driven RDI

Interview participants were asked to discuss the key enabling factors that drive forward RDI within their organisation. Once again, the results obtained were extremely diverse, in part reflecting the diversity within this segment. Nonetheless, the common thread that emerged is the fact that RDI is crucial to ensure both the short-term and long-term sustainability of businesses operating across these sectors, particularly given the rapid pace of change within the business environment. Some respondents mentioned the chronic materials shortages that have been plaguing their industry over the last 18 months, precipitated in part due to the ongoing war in Ukraine coupled with the after-effects of the global COVID-19 pandemic. This has led to rising input costs and thus a drive towards new alternatives that can assist in alleviating these shortages while reducing costs in order to improve competitiveness and maintain profit margins. Others mentioned the knowledge and skills of their existing workforce as they key to their success,

since their ability to follow market trends in a dynamic working environment is essential in order to ensure their long-term sustainability and competitiveness. Respondents also assigned a high score to forward-looking leadership and their role in driving forward a business culture characterised by research and innovation and continuous improvement. By contrast, none of the respondents mentioned the role of government as a facilitator for RDI, nor the availability of public funding. An interesting comment by one respondent was that remote working practices that were largely adopted by necessity in response to the COVID-19 pandemic have actually served to facilitate international collaboration on RDI projects, by allowing them to access new territories and develop new ways of undertaking practical research and accessing specific training, enabling them to tap into new and larger markets down the line.

Limited Financing Opportunities

When it comes to the barriers to RDI, the leading issue mentioned by respondents was the lack of internal finance, given the high costs associated with undertaking quality and purpose-driven research. One respondent specifically-mentioned the difficulties faced by smaller enterprises in accessing external financing or bank loans for RDI purposes.

When pressed on the availability of alternative funding opportunities from public entities or the EU, it was highlighted that although these opportunities do exist, it takes a great deal of time and effort to access such funds, with no guarantee of success, meaning that going through the process of applying for such funds may not be a priority for these businesses, especially smaller enterprises. Other respondents mentioned the lack of qualified employees within the organisation, and the continued struggle to hire talent, as a major stumbling block in conducting and participating in RDI projects. One respondent also mentioned that although the University of Malta produces very good graduates, very often they lack the practical skills required to work within an industrial setting, with training requiring significant amounts of both time and money, thus pointing towards the need for greater workplace exposure during tertiary education in these sectors.

6.7 Manufacturing - plastics, toys, furniture and currency

This sector covers a broad spectrum of operators with unique features, market characteristics and technological dynamics. As such, the generality of the findings derived in this section should be considered with caution. Nonetheless, from the interviews conducted a number of interesting results emerged in terms of the respondents' efforts and perceptions of RDI.

Innovation for Value-Creation

When asked about their perception of RDI, all respondents emphasised its importance for long-term business success. Interestingly, none of the respondents mentioned RDI within the context of reducing costs or improving efficiency. Instead they focused on the ability of RDI investment to lead to the creation of new products or services that would assist in separating them from the rest of their competitors and thus create value for customers.

Indeed, when prompted, respondents stated that for the most part, RDI investment is not explicitly targeted at reducing costs internally, but rather aimed at solving a problem or meeting the need of a customer, who would be willing to pay a premium for such an innovation. In terms of actual involvement in RDI projects, the results were mixed. The majority of respondents were actively involved in some sort of RDI project, with the rest not currently involved in any such projects. The latter cohort mentioned various reasons for their lack of RDI projects, including time and resource constraints, particularly personnel, as well as financial limitations.

One respondent in particular stated that customers in Malta are not interested in innovative products but rather low prices, meaning that it did not make financial sense to invest in RDI, particularly since their market was predominantly local. Among those involved in RDI projects, the general focus appeared to be on product and service improvements, in line with the earlier comments related to customer needs and value creation, with some entities having formal structures in place in order to generate innovative ideas and undertake multiple RDI projects

simultaneously. Some respondents alluded to workplace innovation, although others stated that the high rate of worker turnover meant that innovative practices are in reality difficult to implement since they would require some level of experience to fully take flight.

Customer and Leadership Driven Innovation

Respondents were also asked to discuss the key enabling factors that encourage them to pursue RDI, with two key factors emerging as the leading drivers. Firstly, as suggested to earlier, customer needs and the importance of meeting and anticipating these requirements is perceived to be the leading driver of RDI investment among respondents. According to several respondents, this allows them to remain ahead of the curve while also enabling them to earn a premium on their products or services, since customers are willing to pay for added value when this aligns with their needs and objectives. A number of respondents also mentioned the importance of leadership and company culture in driving innovation forward, specifically highlighting that their entire business model is underpinned by continuous improvement and innovation, and has been since their inception. In terms of government policy, a few respondents mentioned the role of Malta Enterprise as a good source of funding for potential RDI projects, although none specifically mentioned EU funding or other public sources of finance.

Innovation Hindered by Labour Market Shortages and Administrative Burdens

Conversely, respondents were asked to comment on the factors that may inhibit their drive towards investing in RDI. By far, the leading barrier to RDI according to the respondents is the lack of human resources and talent, at all levels of business operations. Some respondents commented on the difficulties faced when recruiting low-skilled operators, which in turn limits their ability to undertake proper training which may lead to future innovative processes and activities. Others specifically mentioned their struggles in attracting high-skilled individuals to work on RDI projects, with many graduates opting for more lucrative careers in other sectors of the Maltese economy like gaming. Some

pointed towards Malta's well-documented lack of STEM graduates as a key factor in limiting the supply of suitable workers, arguing that more needs to be done in order to attract young students towards choosing STEM subjects at secondary school and envisaging careers in research and development via showcases, events, and information sessions. The next key barrier that was mentioned by respondents is the administrative burdens associated with applying for research funding in Malta, both at the pre-award application stage as well as following the award of the grant. Some respondents mentioned that they lacked the time and expertise required in order to navigate the application process successfully, noting that even smaller funds often entailed filling-out various forms and documents which would discourage prospective applicants from proceeding any further.

Others commented on the long timeframes involved in submitting the application and waiting for approval to go-ahead with the project, stating that such delays were not acceptable given the dynamic nature of their market and the need to satisfy customer requirements quickly. Moreover, some respondents specifically highlighted the role of institutions like the University of Malta and MCAST as potential collaborators in RDI projects, given their expertise as well as their administrative know-how in applying for and managing project funds, hence commenting on the need for closer collaborations between industry and these academic institutions in order to boost RDI in Malta.

6.8 Manufacturing - food and beverages

The food and beverage sector has experienced significant challenges over the last few years, mainly due to the various restrictions imposed in light of the COVID-19 pandemic, coupled with recent increases in global commodities like fertilizers and pesticides as a result of supply chain issues brought about by the conflict in Ukraine.

Green RDI

Respondents stated that they are continuously exploring different packaging materials which are

eco-friendlier and possibly do not impact on the cost of packaging, whilst ensuring product preservation. One respondent mentioned that they have recently invested in technology to be able to handle special Heat Set PET bottles which allow product a good shelf life and in turn the product is presented in a shiny (like glass) bottle that is also squeezable. This Heat Set PET bottle is already using 25% recycled material and our current research is to increase this to 35% recycled material within the next 6 months. The aim is to arrive to use 50% recycled material by the end of 2023.

Respondents stated that employees keep records of their good work practices or lessons learned, especially during development projects, and findings are documented regularly. Interestingly, respondents monitor external ideas or technological developments for new or changed products by deploying staff assigned specifically to this task.

RDI for Competitiveness

In terms of factors facilitating respondents' ability to undertake research and development and initiate innovative projects, keeping up with competition in Malta and abroad, desire to export, innovation to reduce business costs, and rapidly changing business environment were cited as the more important, together with forward-looking leadership. Favourable Government policy and availability of public funding were considered not as important to spur innovation. Knowledge and skills of existing workforce was deemed relevant.

Lack of Financing and Scale

As for factors limiting respondents from undertaking research and development and initiating innovative projects, high competition, lack of external finance, lack of internal finance, different priorities within the organisation, and lack of collaboration partners were all deemed more important. Of lesser importance were lack of qualified employees within the organisation, high costs, difficulties in obtaining public grants or subsidies, uncertain market demand, and lack of access to external knowledge.

Insofar as what can be done at both the national and EU level to encourage greater R&D spending and

innovation, the view is that respondents focus a lot of their research on innovation within the food sector and considering the limited availability of knowledge in the country they must spend a lot of time identifying specialized help also from overseas to assist the company on the various projects. Another important factor which one should also consider, is the size of the market that such research is targeted at. The investment that a company makes to undergo research is very much hindered when the company operates in a small market. As an example, focusing on research for a small market like Malta entails the same costs and efforts (with nearly the same investment of resources) as that of a bigger market. Hence, the small dimension of the companies in Malta limits the degree of specialisation that is required for serious research and development projects. There is also a shortage of specialised human resources with qualified personnel moving from the private to public sector at times with a low pay and reducing the availability of such an important resource from research and development projects.

6.9 Gozo

This report also sought to focus on the unique research and innovation landscape and ecosystem that exists in Gozo, which would require a specialised policy focus given that its economic and social realities are different from those in mainland Malta. For example, while Malta's labour market shortages are well-documented, this is perhaps exacerbated in Gozo due to its double-insularity and lack of road connectivity to the mainland, with several Gozitan youths, who collectively account for almost 10% of tertiary level graduates across the Maltese Islands (NSO, 2022), often moving or finding a job in mainland Malta. On the flipside, Gozo's size, standard of living and nimbleness render it an attractive proposition for innovative undertakings and projects, with several fiscal incentives offered in order to attract businesses to set up shop in Gozo. A focus group session was held in Gozo, consisting of a mixture of public officials, trade representatives and entrepreneurs. The purpose of the focus group was to delve into the various realities, challenges and opportunities faced by Gozitan businesses when it comes to RDI.

Innovation for Future-Proofing

A key point that emerged during the focus group was the importance of investing in RDI in order to ensure that businesses maintain a competitive edge and continue to provide value to customers. This is particularly true for hotels operating in Gozo, who are facing unprecedented levels of competition both internationally as well as locally from self-catering establishments and other accommodation.

Various participants commented on the need for data in order to enhance decision-making, not just at the business level but also at the policy level, leveraging concepts like Big Data and AI in order to create value for customers across a wide variety of sectors. Indeed, this lack of granular market and business intelligence was identified as a key weakness in Gozo's drive for innovation and competitiveness, with efforts currently being directed at gathering such data at the national level. In this regard, some participants mentioned that while it would be extremely useful to have access to such data, using it in a productive manner was another matter entirely, since many businesses in Gozo are micro enterprises and lack the necessary resources and skills in order to be able to effectively utilise such data.

Therefore, the focus on data and digitalisation by public authorities should also prioritise the need for training and upskilling of existing staff members, in order to make full use of such innovative resources and improve competitiveness. Some also mentioned the need to attract new foreign direct investment (FDI) to Gozo in areas that would directly or indirectly contribute towards greater RDI. For example, Barts Medical School was cited as an example of FDI that brought significant socioeconomic benefits to Gozo in terms of increased consumption expenditure and rental demand, but which would also yield longer-term benefits in terms of potentially attracting top talent to relocate to Gozo and potentially seeking future employment on the island.

Workplace Innovation

In terms of RDI activities in Gozo, various examples of innovative projects were mentioned by participants across various sectors, with a particular focus on tourism, food and beverages and ICT. A key factor

that was mentioned by participants was the involvement of the Ministry and trade organisations in facilitating the uptake of funds directed at RDI in Gozo, with many emphasising the excellent coordination and working relationship that exists across public sector entities and trade organisations alike. Several participants stated that given the size of most enterprises in Gozo, large-scale RDI projects were simply infeasible due to time and resource constraints. Nonetheless, when prompted, many commented on the strong presence of workplace innovation across Gozitan businesses, with a focus on marginal process improvements and development which may not be as conspicuous as product innovation, but which are still essential for competitiveness. Indeed, a number of participants mentioned that these types of small-scale innovations are often the result of trial and error and experience rather than targeted R&D spending, and very often occur without being labelled as explicitly innovative, particularly in traditional sectors. In fact, many questioned whether these practices were being actively recorded or monitored, which would be useful in order to preserve existing knowledge and build on such improvements.

Resource Constraints

The discussion turned to the factors that facilitate and hinder the undertaking of RDI projects in Gozo, with a specific focus on Gozo's unique socioeconomic realities. Unsurprisingly, the leading issue mentioned by focus group participants is the lack of human resources and skills. Participants repeatedly stressed that businesses were struggling to fill all kinds of vacancies at present, let alone recruit the necessary staff to be able to undertake RDI projects. Despite recent improvements, particularly due to remote working, many participants mentioned that high-skilled Gozitans were still opting to leave Gozo in order to seek employment on the mainland. A number of participants also pointed towards the structure of the Gozitan economy and the limited presence of RDI-driven industries and enterprises, despite various schemes to attract such businesses to set up shop in Gozo. This creates a dual-impact, by limiting investment in large-scale RDI in Gozo while also limiting the number of job opportunities for high-skilled workers in such positions. According to

several participants, one of the key barriers to attracting such businesses is Gozo's limited connectivity to mainland Malta, which despite recent improvements and investment is still limited to ferry crossings with no road or air connections. Another important point mentioned by participants is the lack of economies of scale due to the small size of most businesses operating in Gozo, which limits the viability of RDI investment.

One factor that was mentioned on various occasions during the focus group was the administrative burdens associated with large-scale RDI funding opportunities at every stage of the process, which limits their attractiveness, particularly for micro and small enterprises, with participants calling for greater support in this regard. In addition, the focus group also touched upon the suitability of funding opportunities to cater for the specific needs of Gozitan enterprises when it comes to RDI. Many commented on the fact that these were often designed at the national level, with no specific attention paid to the unique requirements of Gozo, in part due to data and information gaps.

Therefore, a number of participants called for greater delegation of such decisions towards public institutions in Gozo, who would then be in a position to draft a specific Gozo-centric RDI strategy and link funding opportunities to these unique requirements, which in turn should result in a more efficient and effective disbursement and use of funds and greater RDI activity. Finally, participants also highlighted the need for closer collaboration between Gozitan stakeholders and other national institutions like the University of Malta, MCAST, Malta Enterprise and MCST. While matters have ameliorated in recent years, there is still significant scope for improvement, with specific focus on academic institutions in terms of their ability to offer courses and modules that catered for the Gozitan economy at the Gozo campus while also facilitating access to courses offered on the mainland via hybrid and remote learning.

6.10 Academic institutions and government entities

Finally, a number of academic and public sector stakeholders with an active involvement in RDI were contacted and approached in order to gauge their perceptions regarding the state of RDI in Malta and the policy landscape over the coming years. To this end, an online focus group was held with a number of stakeholders, supplemented by various interviews with relevant individuals who were unable to attend the focus group. These included representatives from the Maltese Government, the University of Malta, MCST, MCAST and Malta Enterprise.

A Growing RDI Ecosystem

Malta suffers from a number of structural barriers hindering greater investment in RDI. These include the lack of an RDI-intensive private sector, the slow emergence of a competitive higher education institutional sector, underinvestment in research performing organisations, and the ability to make breakthroughs in established international research funding networks, in particular with regard to participation in research infrastructures.

When asked about the current state of RDI in Malta, most respondents commented on the fact that while there is still much room for improvement, in recent years there has been notable growth in terms of both the quality of RDI projects undertaken in Malta as well as the overall RDI infrastructure, as envisaged in the Smart Specialisation Strategy 2021-2027 published by the MCST. This strategy has provided strategic direction for the government's efforts to drive forward RDI in the coming years, coupled with the recently-launched National R&I Strategic Plan 2023-2027. Respondents commented on the fact that over the last decade, significant investment has been made in enhancing both the research capacity as well as the project and research support infrastructure in academic institutions like the University of Malta and MCAST, in order to increase the likelihood of application success, especially for EU funding programmes like Horizon Europe, alleviate the administrative burdens associated with applying for and managing large-scale projects, improve external collaborations with other academic and non-academic

entities and industry, and enhance the commercialisation potential of RDI projects. This has been complemented by the launch of various funding opportunities offered by MCST and Malta Enterprise across a wide variety of sectors and eligible expenditures, in line with the priority areas identified in the Smart Specialisation Strategy as well as Malta's economic development goals related to digitalisation and greening the economy. According to the respondents, uptake of these funding opportunities so far has been good, with certain funding schemes assisting in attracting various innovative, research-driven start-ups and businesses across diverse sectors like ICT, biometrics and pharmaceuticals, with further funding opportunities in the pipeline as earmarked in the 2023 Budget, while the newly announced Start-Up Agency should also assist in this regard.

From Lab to Market

Respondents also commented on the growing, albeit nascent, number of domestic RDI projects that are moving forward with their commercialisation process, including applications for patents and the establishment of new enterprises, or the licensing of these projects to private companies. These have been assisted by various funding schemes as well as tailored advice provided by the likes of the University of Malta, MCST and Malta Enterprise.

Nonetheless, some respondents mentioned that more could be done to drive the commercialisation of research ideas forward in Malta, via closer collaboration between research institutes and industry which is still somewhat lacking domestically. A number of respondents commented on the fact that this would assist in directing research towards innovative, industry-applicable products, services, or processes, with greater opportunity for commercialisation and entrepreneurship.

Hence, this is often not simply a question of providing additional funding or administrative support, but rather a more holistic process involving outreach from academic institutions to industrial players or vice-versa in order to find common ground and chart a way forward. Recently launched initiatives such as the Innovate Scheme as well as the Postdoctoral Research Scheme should assist in continuing to foster

collaboration across academia and industry. In addition, more support should be provided to researchers already at these institutions in order to assist them with the commercialisation process, since this may be beyond the scope of their knowledge and skillset.

Resource Constraints

Focus group and interview participants were also asked to mention the leading enablers and barriers to the proliferation of RDI in Malta, both now and in the future. A wide spectrum of points was mentioned, although the one factor that repeatedly cropped up was the lack of human resources and talent, which has been a recurring theme throughout these interviews.

This shortage is present across the board, from industry players seeking to hire new recruits to academic institutions looking for researchers and support staff to administer research grants and assist in creating collaborations. Many commented on the delays in trying to obtain a work visa for third country nationals as a further constraint that is currently faced by both industry and academia alike, which leads to delays and often postponement of research projects.

Therefore, some called for the introduction of a fast-track visa for third-country researchers, given the significant shortages of such talent and their importance in helping to boost Malta's innovation performance and ultimately long-term competitiveness. Another key issue mentioned was the administrative burden associated with certain large-scale RDI projects, both at pre- and post-award phases, which may deter prospective applicants and thus hinder RDI investment. This was specifically mentioned in relation to private enterprises, especially SMEs, since academic institutions are well-equipped to handle such matters. Therefore, the possibility of providing active support and training for private businesses in order to apply for funding and manage any potential successful projects was also mentioned by some respondents as a putative initiative to help boost the uptake of RDI funding and projects.

Another interesting factor that was raised during the discussions was the fact that Maltese enterprises are disproportionately impacted by the EU's State Aid regulations, which govern the extent to which Member States can grant financial support to individual beneficiaries due to potential market distortions and uncompetitive practices. This is given the predominance of micro and small enterprises domestically and the size of the local market, which is not conducive to economies of scale. In fact, in October 2022 the European Commission adopted a revised State Aid framework for research, development and innovation, including revisions to the definition of RDI activities and enabling public support for experimentation and testing of new technologies that facilitate the digital and green transformation. It also simplified certain rules to alleviate administrative burdens on grant holders.

Similarly, in November 2022 the Commission launched a consultation on a proposed revision to the de minimis regulations which would raise the ceiling for the total amount granted by a Member State to a single beneficiary over a three-year period, amidst growing inflationary pressures. Nonetheless, the maximum aid intensities for co-financing RDI projects have been maintained, and these may pose issues for SMEs with limited access to external sources of funding or cashflow. Some participants also mentioned that when it comes to the University of Malta and MCAST, significant academic and administrative overlaps are currently present in the two institutions across several fields like engineering and ICT. This leads to fragmented research efforts and competition for research funds and students, as opposed to a more unified approach that would yield greater economies of scale and improved research outcomes.

Finally, several participants also mentioned a lack of public funding to propel RDI in Malta further. Apart from the obvious call for a higher budgetary allocation towards research grants, some participants also mentioned enhanced funding and support for initiatives like the Postdoctoral Researcher scheme to further boost RDI and the availability of research talent in Malta.

7. Recommendations

7. RECOMMENDATIONS

Sustainable economic growth and a high employment rate are essential for the prosperity of the Maltese islands. This is also in line with the EU's objective to ensure sustainable development, based on balanced economic growth and price stability, a highly competitive social market economy, aiming at full employment, social progress and a high level of protection and improvement of the quality of the environment. Achieving this objective requires increasing productivity growth from current levels in all sectors of the economy. Productivity growth also helps boost citizens' well-being when it is based on improving the quality of life including working life (also by adopting innovative work practices) and through the creation of quality jobs. Sustainable productivity growth offers a way of ensuring sound public finances and sustainable provision of social and health care services for an ageing and growing population.

7.1 Recommendations to enhance the scope and role of RDI in Malta

Labour productivity has improved in the Maltese Islands, but there has also been an increase in the number of low-productivity jobs. These include low-pay, low-skill jobs in the service sector and many jobs where people are employed on atypical contracts. This trend has contributed to a slowing down of productivity growth though the economy would not have grown to the levels we have been accustomed to in recent years. In manufacturing productivity growth has been fastest in technology-driven industries and the same applies in sectors such as financial services. However, it should be noted that measuring productivity growth in the services sector using the same indicators as in manufacturing, is a more difficult, if not possible, task.

What is certain is that in manufacturing, investment in new technology increases their share in value added, and the more they contribute to productivity and real earnings growth in our economy. In general, however, when businesses invest wisely in innovation, they and the economy invariably reap the benefits of their investment.

Despite the increase in the various types of innovations in services, such as the use of IT applications, this has not necessarily shown up as productivity growth in productivity statistics. Typically, innovations in the service sector are introduced through acquired technology (ICT, organisational changes, and human capital) rather than through direct R&D spending by service firms themselves. Thus, making productivity comparisons across economic sectors can lead to wrong conclusions, unless the actual content of different sectors is taken into account. This also applies to public services, where productivity growth targets also have to consider social and public policy objectives as well as the requirement to guarantee a climate which is conducive to innovation and productivity growth.

The structure of our economy has changed over the years with an increasing shift of emphasis in factor inputs away from physical capital to human capital. This requires on-going investment in our educational institutions, whether academic or vocational to support continued job creation in the fast-growing, knowledge-intensive sectors and to further boost productivity. At an individual level, productivity growth means that jobs are more secure and that workers have better opportunities to progress in their work

and achieve higher earnings. This improves workers' qualifications and enhances their employability in an ever-changing environment, thus also potentially boosting the firm's overall level of productivity and competitiveness. As world markets determine prices to a large extent and productivity cannot be increased indefinitely by traditional investment in machinery and equipment, other means must be used. Furthermore, productivity growth means that costs rise more slowly, price competitiveness and payroll capacity improve, jobs are more secure (and hence more desirable), work tasks and organisation change, more added value is achieved for customers with fewer resources, profitability improves, growth and survival in the market become possible, and the ground is laid for investment and the development of activities.

Economic growth in Malta has traditionally depended on growth of the labour force, consumption, and the level of investment in what we produce and provide by way of services and rising education levels. We need to rethink this model of economic growth if we are to boost productivity levels. Malta's industrial policy over the years seems to have been driven by diversifying into new economic sectors that typically create strong productivity gains during their early stages, but then mature at a rather rapid rate. This seems to be best expressed in the very sharp increase in migrant labour over the past years, which in turn, reflects the very labour-intensive growth compared to the growth which was driven by RDI activities.

Shifting the focus from corporate tax incentives aimed at attracting investment that creates employment, to one which potentially attracts firms whose explicit focus is on research and innovation would certainly be an important driver of change. A national FDI strategy in favour of research-driven firms would indeed require a significant investment in human capital, as most likely foreign workers with highly specialised skills would need to be recruited to fill in the vacancies. However, the value-added it would create, especially in the medium to long run, could be substantial. Such a change in policy has to however also consider the current economic context. Malta is already facing shortages of labour supply and hence it is also important to find solutions that aim to support

current businesses when investment in human capital and advanced technology-based solutions are becoming more and more important. The situation also calls for policies geared to creating an environment promoting sustainable business growth and innovation and to ensuring healthy competition. Ways must also be found to address the current shortages in labour supply. Solutions via innovative human resources policy and improved integration of migrant workers, measures to reconcile work and family life and gender measures, and by further reforming pension systems need to be found. Further, helping employees to cope in the workplace and maintaining their job motivation are keyways of inducing people to postpone retirement.

The world of work also needs to be made more attractive. An increasing number of those in employment are in the 40-54 age group, which poses a considerable economic challenge. At the same time, it is of paramount importance to prevent young people from dropping out of education and to get them to take part in working life. Quality in work and availability of skilled labour must be improved so that the benefits of new technology, innovation and research, and development can be more readily exploited. The innovativeness of a company and its staff is reflected in the ability to develop and renew product or service concepts so that they create added value for customers. Innovativeness is also the ability to continually improve operational, production and distribution processes together with staff and partners. Innovation can therefore be a tool, a piece of equipment, a machine, a combination of these, a service model, a new way of performing an old task, or a different solution to problems. The ability to change is a key element of productivity.

The recommendations listed below are based on the above considerations and reflect the feedback obtained from the replies to the questionnaires and the various meetings (as well as interviews) which where necessary with key stakeholders from various sectors.

Recommendation 1: More focus to be assigned to the role of Workplace Innovation

Innovation can be defined as the applied competence-based competitive advantage, which can emerge from scientific research, technology, business models, service solutions, design, brands, or methods of organising work and production, and improving the working environment. In a small country context, we consider that innovation at the workplace policy should especially focus on methods of organising work and the way skills are utilised and developed at the workplace, not just on the supply of skilled workers. The situation with regard to working and employment conditions and the working environment is equally important as investing in new technology or equipment. Therefore we recommend that businesses and the public sector should reflect seriously on what kinds of policies and work organisation have been effective in success stories and which enhance innovativeness through investment in skills. To find out what is working at company and organisation level, the Government should support research and the dissemination of research findings. We also believe it is critical for Government to evaluate existing innovation strategies to make sure that a definition of workplace innovation is included in all of them.

Recommendation 2: Increase the access to finance by enhancing the synergies in place between MDB, ME and MCST, especially in relation to the support of start-ups

One factor cited as a limiting factor in the response to the questionnaire is access to finance for innovation and research purposes. We have no information as to how Government will utilise the 5 million euro referred to in the 2023 Budget, but we do recommend that the Malta Development Bank's (MDB) co-lending scheme be utilised for innovation-driven projects in businesses. In this connection we also recommend that MDB works more closely with entities such as Malta Enterprise and the Malta Council for Science and Technology to develop state-aid compliant schemes aimed at financing innovation and research as defined above in businesses. Supporting innovative start-ups is one of MDB's priorities and is also a

national and EU objective in green and digital investment. Hence, such initiatives can support investment in innovation, digitalisation, skills development, re-organisation of work methods and innovative work practices, as well as in technology.

Recommendation 3: The public sector could act an equity investor to promising start-ups. In order to help alleviate the shortage of private equity in the local market.

Building on the motivation which prompted the formulation of Recommendation 2 it may further be noted that although over the recent years public sector entities have been very active in providing incentives and packages to support innovation and start-ups, access to external finance still remains a significant challenge. Start-ups can play a crucial role in driving innovation as well as aid in the exploitation of new markets. Their small size enables them to be more agile, less bureaucratic, and thus able to build an idea into a product and improve it upon consumer demand with faster decision-making processes. Successful start-ups can therefore be key drivers for the creation of new markets or completely transform old markets via product innovation, and in the long run can play an important role as catalysts of competition and market disruption.

It should also be noted that more recently the Government launched the Malta Start-up Residence Programme which relates to the enactment of new rules that recognise the importance of attracting new talent and highly innovative start-ups from around the world and launched the Start-up Residence Programme. The aim of the programme is to support third-country national entrepreneurs and their families and give them the opportunity to bring their ideas to a European market by conferring immigration rights. Whereas this policy will certainly be of benefit to expand the start-up ecosystem in Malta the fact remains that one of the largest challenges facing start-ups, at least at the local level, is the lack of adequate external financing. To this end the Government could perhaps take on a less risk adverse stance and through, for example, the Malta Development Bank, act as an equity investor for those promising start-ups

which have the potential to truly drive RDI forward. This would give a 'stamp of approval' to those promising start-ups, pay dividends to the Maltese nation, and help alleviate the shortage of private equity in the local market.

Recommendation 4: A Shift from Funding RDI Projects to Activities

Existing funding opportunities for RDI (including the tax credits administered by Malta Enterprise) are focussed on individual eligible projects, with a formal application and approval process required prior to the commencement of project activities in order to secure the funding. Apart from the usual pre-award administrative procedures associated with such schemes, which may be a burden for some businesses (although these are being streamlined over time), the current processes delay the launch of RDI projects and initiatives, which may be non-feasible for businesses who require immediate results in order to commence the commercialisation process to improve products/services/processes to maintain a competitive edge, target new markets, and reduce costs or simply to respond to customer requirements. Such project-centric schemes may therefore dissuade private businesses from applying for funding.

Therefore, the Maltese Government could consider introducing a new, albeit complementary, form of RDI funding based on RDI activities than projects, modelled on the UK Government's tax credit schemes for RDI. Under this new scheme, tax credits or cash payments would be provided to businesses based on their annual reported expenditure on RDI activities, with eligible expenditures defined beforehand in order to provide clarity. These activities may include efforts to create new products, services, or processes, or changing or modifying existing products, services or processes, including workplace innovation, across all sectors of the economy. The eligible costs would include any expenditures on staff, materials and consumables used in the RDI process, software, etc., all of which would be reported specifically as part of the claim made by businesses (e.g., via their audited accounts), with SMEs receiving a higher tax credit than larger businesses. Moreover, businesses would still be eligible for tax credits even if the intended

innovation was unsuccessful or not fully realised, in order to alleviate the inherent risk associated with such activities.

Recommendation 5: An RDI Vision for Gozo

Gozo has long been earmarked by the Maltese Government as having significant potential when it comes to the development, testing, and deployment of innovative projects and initiatives, given its size. At the same time, Gozo's unique socio-economic and geographical realities require a tailored approach to both the provision of RDI funds and well as the type and prioritisation of projects eligible for funding. Greater autonomy should therefore be given to institutions operating in Gozo in terms of the design, allocation, and disbursement of research funding (e.g., GRDA, Ministry for Gozo), as well as the allocation of RDI-specific resources, leveraging the close working relationship that exists across these stakeholders, in partnership with the Gozo Chamber and other trade representatives. This should result in a quicker deployment of funding as well as a more curated approach towards the design of RDI funding opportunities in Gozo, which in turn should also assist in promoting greater innovation within the island.

Recommendation 6: Administrative support for pre and post award of funds

A key issue that consistently emerged from the interviews and focus group sessions was the need for specific support in order to assist businesses navigate the various administrative requirements involved both at the pre-award and post-award phases of the project funding process, including the preparation of documents, additional materials, reporting, etc. These requirements are significant for businesses (especially SMEs), who may not have the time, knowledge, or the personnel necessary in order to manage the process effectively, leading to potential delays in the disbursement or potential loss of funding, and thus, dissuading businesses from applying for such funds. By contrast, institutions like the University of Malta have dedicated teams who assist researchers both at the application stage as well as with the project management and administrative aspects of funded

research projects, encouraging higher volumes of applications from such institutions while improving the likelihood of success. Therefore, there is scope for Government to provide such services to businesses, particularly for EU-funded and large-scale RDI projects, with priority given to SMEs. These services could take the form of a dedicated, independent research and project support office, with the remit to assist businesses and prospective applicants with the administrative and project management aspects both pre- and post-award.

Recommendation 7: **Increase the Post-doctoral schemes across several key sectors to enhance the link between academia and industry with the aim to boost innovation**

Extend the postdoctoral scheme across several key sectors and with government assistance, to also include other research like postgraduate (Masters-level) researchers. A key element of a knowledge-based economy is a strong base of researchers and research capacity, and the ability to apply research to generate economic value. Universities are a critical hub for research, in particular through undertaking research themselves, partnering with industry and developing individual researchers.

PhD candidates and graduates are a critical link between academia and industry, both in terms of their individual research and the skills and expertise they can bring to organisations in diverse sectors during and post their candidatures. Through their training, PhD candidates often work at the cutting edge of innovation and develop skill sets that suit exploration of new knowledge. This positions PhD graduates well to help industry develop new and innovative products and services. A higher level of engagement between PhDs and industry could be achieved through for example introducing tax incentives which encourage businesses to engage with PhDs and by linking a portion of PhD scholarships to industry.

Recommendation 8: **Enhance further the collaboration between academia and industry through a more extensive use of Knowledge Transfer Partnerships**

One point which is often argued by industry professionals, especially those operating within capital intensive sectors, such as manufacturing, is that, although our academic institutions produce very good quality graduates and postgraduates, more often than not they lack the practical skills needed to work in an industrial environment which potentially hinders their ability to develop ideas and research which could drive innovation forward. Looking ahead we recommend a more extensive use of Knowledge Transfer Partnerships (KTP). Such schemes have been an important catalyst within several countries to help in bringing together the worlds of science and business and fostering industrial talents.

KTP programmes support the placement of a graduate student to a company which can aid the company in terms of specific research and innovation needs of that company whilst simultaneously facilitating access to the knowledge resources of the academic sector. From this exchange, academia is also expected to benefit as it gains new insights for teaching and for the experience gained by the graduate student will aid in the identification of new research themes thanks to the connection with industry, as well as clearly aid the graduate student, thanks to the exposure and experience gained. It should however be noted that for such KTP innovative collaborations to be successful there need to be sufficient funding incentives put in place to make such schemes attractive to researchers, academic institutions, and industry.

Recommendation 9: Develop Malta's position as a regional Innovation hub with specific focus on Digital and Future Technologies

It is widely recognized that regional hubs have become increasingly important as key spatial units to drive innovation as the main source of economic growth. Such innovation hubs could enhance the cluster structure of the economy in terms of the increased relationships and flows which connect the different stakeholders and parts of the innovation system themselves as well as serve to attract talent to the island. Indeed, given Malta's strategic position in the Mediterranean area, it could play an important role as a regional Research and Innovation hub, particularly for the Southern EU area. Furthermore, given the

positive developments already under way pertaining to the fields of digital and future technologies, such as Blockchain, Fintech, Artificial Intelligence and Digital Games, it may be argued that Malta should concentrate on developing an innovation hub centred around these areas given the potential to gain competitive advantages. It should further be noted that these areas can at present also be supported by research institutes and centres which are already undertaking high quality research within our academic institutions. Furthermore, the small size of the Maltese economy makes it highly suitable as a testbed for research concepts or prototyping especially for those firms seeking to applying such technologies particularly within the context and scope of Industry 4.0 and be at the forefront of developments within the Industry 5.0 framework.

Recommendation 10:
Include STEM Thinking as part of the basic curriculum within primary and secondary schools with the aim of increasing the number of future STEM graduates.

The supply of local researchers is a key requirement in order to ensure that RDI activities can be sustained in the years to come. However, one notes that over the recent years the number of Science, Technology, Engineering and Mathematics (STEM) graduates has been on a declining path. Whereas it is extremely challenging to identify a short-term solution to this issue, various policies which should yield medium to long term benefits have been put forward by numerous institutions in order to overcome this challenge. One clear policy that should be highlighted is that of teaching STEM thinking in primary and secondary schools as part of the basic curriculum.

Although within our primary and secondary schools there are syllabi in place for students to acquire STEM knowledge, it may be argued that they are not leading to very high levels of creativity, computational skills, and critical thinking within our society. STEM thinking goes beyond a specific career path as it includes universal problem-solving skills based on the power of abstracting unnecessary details and seeing patterns across multi-disciplinary domains. It may also help to address various misconceptions pertaining to STEM

subjects and STEM careers, which perhaps could deter students from become engaged with the subjects themselves. It should also be noted that STEM education does not only help students who plan to go into STEM careers. The focus on logical thought processes and problem-solving, as well as critical thinking, allows students to develop mental habits that will help them succeed in any field. Crucially STEM subjects also help students to think critically and come up with their own solutions. As a result, students who receive a quality STEM education are thus trained to become more productive in their work practices and have the potential to be the next generation of innovators.

7.2 Recommendations by implementation priority and identification of key stakeholders and sectors

This section categorises the recommendations put forward in this document by implementation priority on the basis of the expert judgement of the authors of this report, while also specifying the key stakeholders and sectors which are mostly associated with the implementation of each recommendation. High priority recommendations are those which, according to the authors, require immediate attention especially when taking into consideration the need to enhance productivity and economic resilience. Therefore, their implementation should ideally take place within a year.

Medium priority recommendations might not require immediate attention to the same degree as those identified as high priority, or may require longer than 1 year for them to be implemented in a practical manner due to various administrative and financial challenges. It should be noted that they are still deemed to be of significant importance to the overall expansion of RDI activities, and that such recommendations should ideally be implemented within the next two to three years. Low priority refers to the fact that while the recommendation is considered relevant, in contrast to the other recommendations, the authors are of the opinion that other initiatives might be considered more important, within the context of the current challenges

faced by the Maltese economy to drive RDI forward and thus may be seen as having an implementation timeframe of between three to five years.

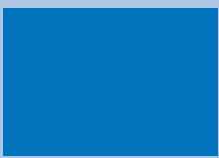

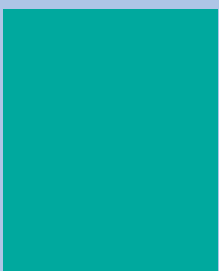
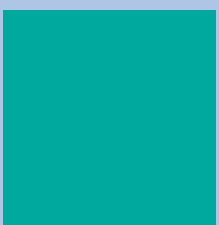
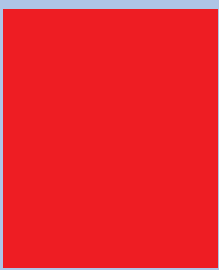
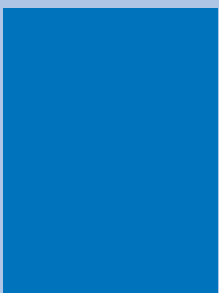

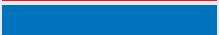

Furthermore, it should be noted that a number of recommendations may not be aimed at one particular sectoral group area, but should be implemented across

all the individual sectors included within the four sectoral group areas⁹. Table 7.1 presents the ratings provided based on high (red), medium (blue), and low (green) priority, and lists the key stakeholders and sectoral groups areas which are mostly associated with the implementation of each of the 10 recommendations presented in this report.

Table 7.1: Priority categorization and identification of relevant stakeholders and sectoral group areas for each recommendation

Recommendation	Implementation Priority	Key Stakeholder(s)	Priority Sectoral Group Areas
1: More focus to be assigned to the role of Workplace Innovation.		Malta Enterprise, Chamber of Commerce, Chamber of SMEs, Ministry for Finance and Employment, Trade Unions, Parliamentary Secretariat for Youth, Research and Innovation.	1 -- 4
2: Increase the access to finance by enhancing the synergies in place between MDB, ME and MCST, especially in relation to the support of start-ups.		Malta Enterprise, Malta Development Bank, MCST, Financial institutions, State aid monitoring board. Parliamentary Secretariat for Youth, Research and Innovation.	3 , 4
3: The public sector could act an equity investor to promising start-ups. In order to help alleviate the shortage of private equity in the local market.		Malta Enterprise, Malta Development Bank, MCST, Financial institutions, State aid monitoring board. Mimcol, Parliamentary Secretariat for Youth, Research and Innovation.	3 , 4
4: A shift from funding RDI Projects to Activities.		Malta Enterprise, Ministry of Finance and Employment, MCST.	1 -- 4

⁹ The list of the sectors included in each of the four sectoral group areas is presented in Table 5.1 with Chapter 5.

5: An RDI Vision for Gozo.		GRDA, Gozo Business Chamber, Ministry for Gozo.	2, 3, 4
6: Administrative support for pre and post award of funds.		Malta Enterprise, MCST, Parliamentary Secretariat for Youth, Research and Innovation.	1 -- 4
7: Increase the Post-doctoral schemes across several key sectors to enhance the link between academia and industry with the aim to boost innovation.		University of Malta, MCAST , Chamber of Commerce, Ministry for Education.	1 , 2 , 3
8: Enhance further the collaboration between academia and industry through a more extensive use of Knowledge Transfer Partnerships.		University of Malta, MCAST , Chamber of Commerce, Ministry for Education.	1 ,2, 3
9: Develop Malta's position as a regional Innovation hub with specific focus on Digital and Future Technologies.		MFSA, MDIA, Tech.mt, Finance Malta, GamingMalta, Ministry for the Economy, University of Malta	3, 4
10: Include STEM Thinking as part of the basic curriculum within primary and secondary schools with the aim of increasing the number of future STEM graduates.		Ministry for Education, University of Malta, MCAST, Malta Union of Teachers, Malta Chamber of Scientists.	1 -- 4
Implementation Priority Rating <div> <div>High</div> <div>Medium</div> <div>Low</div> </div> <div>    </div>			
Source: Authors' Own Contribution			

7.3 Assessment of progress on past NPB recommendations associated with the area of RDI

This section presents an assessment, based on expert judgement, of the recommendations put forward over the past NPB annual reports linked to the thematic area of Research development and innovation.

7.3.1 2019 NPB Research and Innovation Recommendations

Recommendation 4.1: Greater leadership role by Government in promoting R&I, through institutional reforms and closer co-ordination across R&I policy making entities.

As had been expressed by the EC peer review of the Maltese R&I system, the under-investment in research and development (as evidenced by the distance from the target of 2% of GDP expenditure on R&D by 2020) is likely to stem from a lack of ownership of R&I at the highest Governmental level.

The peer review suggested that Government plays a more active leadership role by placing clearer priority on research and innovation. This recommendation was followed up the MCST taking a key role in R&I Strategy which it did. Significantly, in the 2023 Budget, Government is committing 5 million euros for a new programme titled Technology Extension Support with the participation of the private sector to fund projects with an emphasis on innovation. In addition, other programmes such as Horizon Europe and the National STEM Community Fund will be given priority to support research and innovation. It must be said that the amount is relatively low but, it recognises the role of the State in providing financial support where so far, funding has been lacking.

Thematic Area 3:

Research and Innovation

Policy recommendation: Developing a comprehensive monitoring system which enables a more quantitative/ objective evaluation of innovation outputs and impacts, for example through a set of monitorable indicators.

This recommendation, which places emphasis on policy makers increasingly seeking for policy measures to be backed up by rigorously established objective evidence, has not been followed up. We believe that continuous and structured monitoring of projects with a high content of research and innovation is necessary to provide information and updating in an area that can effectively enhance productivity in the Maltese economy.

7.3.2 2020 NPB research and innovation recommendations

Recommendation A.4:

In spite of COVID-19, and assuming workers are motivated, productivity can be increased in small steps through rationalising and streamlining techniques and developing products and services through application of more intelligent production methods

We do not think that this recommendation has been sufficiently followed up. Yes, a number of businesses have developed new services during COVID-19, such as for example the use of teleworking practices, but the application of innovative work practices and methods remains largely at pre-COVID-19 levels.

Recommendation B.5:

Provide further support to SMEs to help them become more competitive in their business/production processes, and products or services using digital technologies

The 2023 Budget refers to the setting up of a one-stop shop for start-ups to be launched in 2023 and incentives for digitisation projects.

Recommendation B.7:

The public sector should further recognize the strategic importance of research, development and innovation (RDI) and increase as well as intensify its expenditure in this area

As referred to earlier, in the 2023 Budget, Government is committing 5 million euros for a new programme titled Technology Extension Support with the participation of the private sector to fund projects with an emphasis on innovation. We expect expenditure in 2024 to increase, to further support research and innovation in the Maltese economy especially in areas that help boost productivity.

Recommendation B.9:

Research support initiatives, such as the IPAS+ schemes, should be intensified and supported further

This recommendation has been followed up with the Malta Council for Science and Technology (MCST) launching proposals under the Internationalisation Partnership Awards Scheme Plus (IPAS+). The Scheme is divided into two options.

Option A: opportunities for collaborative initiatives between Maltese entities and at least one foreign entity of a proven track record of excellence. Proposals should describe the nature of the joint activities that would be funded through the Award. Applicants are to demonstrate how the proposed activities contribute towards and align with achieving the goals of the National R&I Strategy, and to describe the potential of any activities to become self-sustaining or generate longer-term outcomes.

Option B: opportunities for Maltese entities intending to submit a Horizon Europe proposal as the coordinator of the consortium, to engage a service provider (local or foreign), who will be supporting the applicant through proposal writing and submission.

Recommendation B.10: Enhance the cooperation between Malta Enterprise (ME) and MCST to ensure that both private and public sector entities, engaging in RDI, are readily assisted with support to tap into the right funding instruments

We note that the level of collaboration between ME and MCST has increased, as has the support to private and public sector entities engaging in RDI.

7.3.3 2021 NPB research and innovation recommendations

Last year's recommendations on research and innovation refer mainly to the field of digitalisation. The recommendations pointed out that businesses need to innovate and exploit new opportunities arising from digitisation and research. However, the recommendations are generic and do not refer to the somewhat circumstances facing SMEs in a rapidly changing economic environment with a growing services sector and increasing reliance in the labour market on third country nationals.

The 2021 report refers to the role of the Government in providing the appropriate policy framework and infrastructure for innovation and research. Again, this recommendation is deemed generic and whereas Government's role is crucial, this role has to be framed with the Recovery and Resilience Plans (RRPs) as outlined in the largely EU-funded Recovery and Resilience Facility where digitalisation and innovation aimed at the greening of the economy features very prominently.

The RRP's are also aimed at supporting digital transformation in businesses as well as in people. The human-centric approach is crucial since this will support the economy and business in the change process.

Recommendation 6:

Given the lack of awareness of some of the main sector-specific technologies, sectoral demonstrator sites could be explored and aimed at allowing companies to learn about such technologies and how they can apply them to their operations.

Recommendation 6 refers to sectoral demonstrator sites for businesses but such a recommendation was not followed up on as yet. The same can be said for Recommendation 7 and the link between business innovation and educational institutions.

Recommendation 7:

Provide support to firms to develop technology-driven pilot projects such as automation processes, robotics, and artificial intelligence in collaboration with educational institutes that would also act as exemplars to other firms.

This recommendation is actually referred to in more detail and within the context of the RRP's in this year's report. The idea of pilot projects has some merit but the schemes currently provided by Malta Enterprise as defined in this year's report, as well as schemes falling under the RRP's go beyond the idea of pilot projects and are likely to achieve results in a shorter time frame than taking the pilot project approach. Also, the outcome of schemes aimed at businesses falling under the RRP's can be measured.

Recommendation 8:

Enhance the awareness surrounding digital transformation opportunities for specific sectors that are encountering challenges such as agricultural and construction.

As for Recommendation 8, this too was not followed up but this recommendation is limited to awareness raising and as such is very unlikely to have any impact on either the construction and agriculture sectors. In a sense, innovation in agriculture will be covered in the new Rural Development Plan and the recommendation in last year's report will be addressed more precisely and with indicators of success or otherwise, as is expected in a largely EU-funded plan of action.

Recommendation 9:

Develop more collaboration between academia and private sector especially through traineeships and dissertation projects which can serve as pilot transformation projects.

Recommendation 9 is aimed at developing more collaboration between academia and the private sector, especially through traineeships and dissertation projects which can serve as pilot transformation projects. This is similar to Recommendation 7 and no in-roads were made in this connection. There has been a limited number of cases where the private sector has collaborated with education institutions, but coordinating public and private sector efforts, and resources to develop an ecosystem for innovation-driven growth, both to encourage local R&I and to attract R&I-based foreign investment, is crucial. As explained in the strategy itself there is evidence that investments in R&I are increasing primarily in the public sector and the drive up to 2020 is to use national and European resources strategically to leverage more effectively private sector investments and efforts in research and innovation. The ultimate goal is to generate innovation-based growth through the development of local and international partnerships as well as to attract more R&I-based foreign investment into Malta ¹⁰.

¹⁰ <http://mcst.gov.mt/wp-content/uploads/2017/02/National-RI-Strategy-2020-June-2014.pdf>

Recommendation 10:
Gozo has the potential of becoming a living testing hub for new technologies including drones, agri-tech and relating to smart buildings and mobility. Establishing a dedicated research centre can support this potential.

The final recommendation related to RDI in the 2021 NPB report, recommendation 10, concerns Gozo as having the potential of becoming a living testing hub for new technologies including drones, agri-tech and related to smart buildings and mobility. Again, there was no follow-up to this recommendation and no attempt to establish dedicated research to support the recommendation. That said, this recommendation is consistent with the reasoning put forward in the National Research and Innovation Strategy 2020 where it is argued that ‘Malta’s small size is often recognised as an opportunity for promoting Malta as a test-bed for new technologies prior to roll out on a larger scale.’¹

We highlight the role of MCEST in supporting research and innovation as well as other Horizon Europe which is the EU’s key funding programme for research and innovation. Besides, tackling climate change and helping to achieve the UN’s Sustainable Development Goals, the funds are also intended to boost the EU’s competitiveness and growth. The programme also facilitates collaboration and strengthens the impact of research and innovation in developing, supporting and implementing EU policies. It supports the creation and better diffusion of excellent knowledge and technologies. Given the financial restrictions caused indirectly by the war in Ukraine, efficient and effective use of EU funds available through MCEST and Horizon Europe is now crucial and should be aimed at projects that tangibly result in boosting productivity in export-oriented enterprises based in our economy.

This activity creates jobs, fully engages the EU’s talent pool, boosts economic growth, promotes industrial competitiveness, and optimises investment impact within a strengthened European Research Area.

In conclusion, we also highlight the relevance of the European Commission’s State aid Framework for

research, development and innovation (the RDI Framework) that incentivises risky research, development and innovation (RDI) activities, which would not occur in the absence of public support. In this connection, the Commission launched a public consultation in April 2021 with a view to simplifying the existing State aid Framework. The objective is to make it easier for Member States to support research, development and innovation, including for SMEs and innovation clusters, while ensuring that possible competition distortions are kept to the minimum as well as providing the right incentives to enable the green and digital transition of the EU.

Following the public consultation and the contributions received, the Commission continued its reflections on how to modernise the RDI Framework and make it future proof. Given the importance of green and digital transitions, and the resilience of the Single Market, these reflections on RDI Framework modernisation include for example areas such as testing and experimenting infrastructure as well as developing and delivering breakthrough technologies. The revised RDI Framework was adopted in 2022. In our view simplifying the existing State aid Framework, to help support SMEs in our economy and we also believe that this support, possibly through loan guarantees, could be provided by the Malta Development Bank.

8. Conclusion

8. CONCLUSION

The 2022 Productivity Report focuses on research and innovation as drivers of productivity and competitiveness. As stated in the report, the Maltese Islands still have some way to go to reach the levels of RDI spending and achievements of most of its European counterparts. Whereas the challenges facing the Maltese Islands in respect of RDI have been noted in this report, on the basis of feedback from key stakeholders as well as our research, we have drawn up a number of recommendations that we believe can easily be turned into policy which would boost RDI, keeping in mind the scale, limitations but also the strengths of the Maltese economy.

The recommendations also need to be assessed in light of Government's current policy framework based on the twin objectives set out by the EU: digitalisation and the greening of the Maltese economy. The transitions towards a more digital and more sustainable (socially, environmentally, and economically) is both challenging and costly but the opportunities for RDI as well as for established and new economic sectors are significant. This too is borne out of from the feedback derived from stakeholders.

We are very confident that our recommendations offer a reasoned and relevant way forward to boost RDI and as a result productivity and competitiveness in the economic sectors covered in this report. The recommendations recognise Malta's size as a limitation and argues strongly for workplace innovation with a focus on skills development and digitalisation of work processes as part of RDI.

Access to finance is critical for RDI and this is precisely why we recommend that the Malta Development Bank's (MDB) co-lending scheme be utilised for innovation-driven projects in businesses. In this connection we also recommend that MDB works closely with entities such as Malta Enterprise and the Malta Council for Science and Technology to develop schemes aimed at financing innovation (and research)

as defined above in businesses. In this connection, we also recommend that the public sector acts as an equity investor to promising start-ups, in order to help alleviate the shortage of private equity in the Maltese market. This would give a huge boost to start-ups and pay dividends to the Maltese economy.

We recommend that RDI funding be directed towards RDI activities (not only project-based) as modelled on the UK Government's tax credit schemes for RDI. Under this proposed scheme, tax credits or cash payments would be provided to businesses based on their annual reported expenditure on RDI activities, with eligible expenditures defined beforehand in order to provide clarity. These activities may include efforts to create new products, services, processes, and workplace innovation, across all sectors of the economy.

Another recommendation recognises Gozo's unique socio-economic and geographical realities which in our view require a tailored approach to both the provision of RDI funds, and the type and prioritisation of projects eligible for funding with institutions like GRDA being given greater autonomy.

A key issue that consistently emerged from the interviews and focus group sessions was the need for specific support in order to assist businesses

navigate the various administrative requirements involved both at the pre-award and post-award phases of the project funding process, including the preparation of documents, additional materials, reporting, etc. We believe there is scope for Government to provide such services to businesses, particularly for EU-funded and large-scale RDI projects, with priority given to SMEs.

We also propose that the postdoctoral scheme be extended across several key sectors and with Government assistance, to also include other research like postgraduate (Masters-level) researchers. A key element of a knowledge-based economy is a strong base of researchers and research capacity, and the ability to apply research to generate economic value. This recommendation would make a difference.

In a similar vein, we recommend a more extensive use of Knowledge Transfer Partnerships (KTP). Such schemes have been an important catalyst within several countries to help in bringing together the worlds of science and business, and fostering industrial talents. KTP programmes support the placement of a graduate student to a company which can aid the company in terms of specific research and innovation needs whilst simultaneously facilitating access to the knowledge resources of the academic sector.

We also propose to develop Malta's position as a regional Innovation hub with specific focus on Digital and Future Technologies such as Artificial intelligence and Blockchain. Regional hubs have become increasingly important as key spatial units to drive innovation as the main source of economic growth. Such innovation hubs could enhance the cluster structure of the economy in terms of the increased relationships and flows which connect the different stakeholders and parts of the innovation system to attract talent to Malta.

The final recommendation is to include STEM thinking as part of the basic curriculum within primary and secondary schools with the aim of increasing the number of future STEM graduates.

We are convinced that these ten recommendations can make a significant difference to Malta's efforts in RDI and thereby boost productivity and competitiveness, especially in the medium and long-term. Some of our recommendations such as the emphasis placed on workplace innovation and proposals on access to finance for start-ups, and for investment in technology, would also have positive impacts in the short-term.

Essentially and within a reasonable time frame, these recommendations can translate into policy measures using financial resources that could be made available mainly through existing EU or national funding. We are confident that Maltese Authorities will in time own these recommendations and apply them for the continued prosperity and well-being of the Maltese Islands.

Appendix I

REFERENCES

- Acs, Z.J., Audretsch, D.B. and Feldman, M.P., 1994. R & D spillovers and recipient firm size. *The review of Economics and Statistics*, pp.336-340.
- Aghion, P., 2018. Innovation and growth from a Schumpeterian perspective. *Revue d'Économie politique*, 128(5), pp.693-711.
- Aghion, P., Antonin, C. and Bunel, S., 2021. *The power of creative destruction*. a Cambridge, Massachusetts: The Belknap Press of Harvard University Press.
- Aghion, P., Bloom, N., Blundell, R., Griffith, R. and Howitt, P., 2005. Competition and innovation: An inverted-U relationship. *The quarterly journal of economics*, 120(2), pp.701-728.
- Aghion, P., Blundell, R., Griffith, R., Howitt, P. and Prantl, S., 2009. The effects of entry on incumbent innovation and productivity. *The Review of Economics and Statistics*, 91(1), pp.20-32.
- Aghion, P., Ljungqvist, L., Howitt, P., Howitt, P. W., Brant-Collett, M., & García-Peñalosa, C. (1998). *Endogenous growth theory*. MIT press.
- Aghion, P., Howitt, P. and Prantl, S., 2015. Patent rights, product market reforms, and innovation. *Journal of Economic Growth*, 20(3), pp.223-262.
- Akcigit, U. and Kerr, W.R., 2018. Growth through heterogeneous innovations. *Journal of Political Economy*, 126(4), pp.1374-1443.
- Akcigit, Ufuk, Salome Baslandze, and Stefanie Stantcheva. 2017. 'Taxation and the International Mobility of Inventors.' *American Economic Review* 106 (10): 2930-81.
- Akcigit, Ufuk, John Grigsby, Tom Nicholas, and Stefanie Stantcheva. 2018. 'Taxation and Innovation in the 20th Century.' Working Paper 24982, National Bureau of Economic Research, Cambridge, MA.
- Almeida, P. and Kogut, B., 1999. Localisation of knowledge and the mobility of engineers in regional networks. *Management science*, 45(7), pp.905-917.
- Andersen, E., 2009. *Schumpeter's Evolutionary Economics: A Theoretical, Historical and Statistical Analysis of the Engine of Capitalism (The Anthem Other Canon Series)*. Anthem Press India.
- Andersen, E.S., 2011. *Joseph A. Schumpeter: A Theory of Social and Economic Evolution*, New York: Palgrave Macmillan.
- Anselin, L., Varga, A. and Acs, Z., 1997. Local geographic spillovers between university research and high technology innovations. *Journal of urban economics*, 42(3), pp.422-448.
- Arrow, Kenneth. 1962 'Economic Welfare and Allocation of Resources for Invention.' In *The Rate and Direction of Inventive Activity: Economic and Social Factors*, 609-26. Princeton, NJ: Princeton University Press.
- Ashford, Nicholas A. "An innovation-based strategy for a sustainable environment." *Innovation-oriented environmental regulation*. Physica, Heidelberg, 2000. 67-107.
- Atkin, David, Amit Khandelwal, and Adam Osman. 2017. 'Exporting and Firm Performance: Evidence from a Randomized Experiment.' *Quarterly Journal of Economics* 132 (2): 551-615.
- Audretsch, David B., and Maksim Belitski. "The role of R&D and knowledge spillovers in innovation and productivity." *European Economic Review* 123 (2020): 103391.

- Audretsch, D. and Feldman, M. 2004. "Knowledge spillovers and the geography of innovation". In *Handbook of Urban and Regional Economics*, Edited by: V Henderson, J. and Thisse, J. F. Amsterdam: North-Holland.
- Audretsch, D.B. and Feldman, M.P., 1996. R&D spillovers and the geography of innovation and production. *The American economic review*, 86(3), pp.630-640.
- Autor, David, Claudia Goldin, and Larry Katz. 2020. 'The Race between Education and Technology Revisited.' *American Economic Review Papers and Proceedings*. Presented San Diego, CA, January 4, 2020.
- Azoulay, Pierre, Joshua S. Graff Zivin, Danielle Li, and Bhaven N. Sampat. 2019. 'Public R&D Investments and Private Sector Patenting: Evidence from NIH Funding Rules.' *Review of Economic Studies* 86 (1): 117-52.
- Balconi, M., Breschi, S. and Lissoni, F., 2004. Networks of inventors and the role of academia: an exploration of Italian patent data. *Research policy*, 33(1), pp.127-145.
- Bernstein, Shai, Rebecca Diamond, Timothy McQuade, and Beatriz Pousada. 2018. 'The Contribution of High-Skilled Immigrants to Innovation in the United States.' Unpublished, Stanford University Graduate School of Business, Stanford, CA.
- Blundell, R., Griffith, R. and Reenen, JV, 1995. Dynamic count data models of technological innovation. *The economic journal*, 105(429), pp.333-344.
- Bloom, Nicholas, Rachel Griffith, and John Van Reenen. 2002. 'Do R&D Tax Credits Work? Evidence from a Panel of Countries, 1979-1997.' *Journal of Public Economics* 85 (1): 1-31.
- Bloom, Nicholas, and Rachel Griffith. 2005. 'The Internationalization of UK R&D.' *Fiscal Studies* 22 (3): 337-55.
- Bloom, Nicholas, Paul Romer, Stephen Terry, and John Van Reenen. 2014. 'Trapped Factors and China's Impact on Global Growth.' Working Paper 19951, National Bureau of Economic Research, Cambridge, MA.
- Bloom, Nicholas, John Van Reenen, and Heidi Williams. 2019. "A Toolkit of Policies to Promote Innovation." *Journal of Economic Perspectives*, 33 (3): 163-84.
- Blundell, R., Griffith, R. and Van Reenen, J., 1999. Market share, market value and innovation in a panel of British manufacturing firms. *The review of economic studies*, 66(3), pp.529-554.
- Blundell, R.W., Jaravel, X. and Toivanen, O., 2021. Inequality and creative destruction. CEPR Discussion Paper No. DP16867, Available at SSRN: <https://ssrn.com/abstract=4026750>
- Boldrin M., and Levine D., 2008., *Against Intellectual Monopoly*, Cambridge, MA: Cambridge University Press.
- Boschma, R. A., and K. Frenken. 2011. "Technological Relatedness and Regional Branching." In *Dynamic Geographies of Knowledge Creation and Innovation*, edited by H. Bathlet, M. P. Feldman, and D. F. Kogler, 64-81. London: Taylor & Francis/Routledge.
- Bottazzi, L. and Peri, G., 2003. Innovation and spillovers in regions: Evidence from European patent data. *European economic review*, 47(4), pp.687-710.
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, 3(2), 77-101.
- Breschi, S., Malerba, F. and Orsenigo, L., 2000. Technological regimes and Schumpeterian patterns of innovation. *The economic journal*, 110(463), pp.388-410.
- Breschi, S. and Lissoni, F., 2009. Mobility of skilled workers and co-invention networks: an anatomy of localised knowledge flows. *Journal of economic geography*, 9(4), pp.439-468.
- Britten, N. (1995). Qualitative research: qualitative interviews in medical research. *Bmj*, 311(6999), 251-253.
- Cantwell, J. (2005). Innovation and competitiveness. *The Oxford handbook of innovation*, 543-567. [GET]

- Chapman, S.A. and Meliciani, V., 2012. Income Disparities in the Enlarged EU: Socioeconomic, Specialisation and Geographical Clusters. *Tijdschrift voor economische en sociale geografie*, 103(3), pp.293-311.
- Cooke, P., 1997. Regions in a global market: the experiences of Wales and Baden-Wurttemberg. *Review of international political economy*, 4(2), pp.349-381.
- Cooke, P., Asheim, B., Boschma, R., Shyarts, D., T^dtling, F. and Martin, R., 2015. *Handbook of regional innovation and growth*. Cheltenham, U.K.: Edward Elgar.
- Crescenzi, R. and Rodriguez-Pose, A., 2011. *Innovation and Regional Growth in the European Union*. Berlin, Heidelberg: Springer-Verlag Berlin Heidelberg.
- Crescenzi, R., 2005. Innovation and regional growth in the enlarged Europe: the role of local innovative capabilities, peripherality, and education. *Growth and Change*, 36(4), pp.471-507.
- Doran, Kirk, and Chungeun Yoon. 2020. 'Immigration and Invention: Evidence from the Quota Acts.' Unpublished, University of Notre Dame.
- Echchakoui, S. and Barka, N., 2020. Industry 4.0 and its impact in plastics industry: A literature review. *Journal of Industrial Information Integration*, 20, p.100172.s
- ElFar, O.A., Chang, C.K., Leong, H.Y., Peter, A.P., Chew, KW and Show, P.L., 2021. Prospects of Industry 5.0 in algae: Customisation of production and new advance technology for clean bioenergy generation. *Energy Conversion and Management: X*, 10, p.100048.
- European Commission. (n.d. -b). *Innovation Union*. Innovation Union - European Commission. Retrieved June 21, 2022, from https://ec.europa.eu/info/research-and-innovation/strategy/past-research-and-innovation-policy-goals/innovation-union_en
- European Commission. (n.d.-a). *Horizon Europe*. Horizon Europe - European Commission. Retrieved June 21, 2022, from https://ec.europa.eu/info/research-and-innovation/strategy/past-research-and-innovation/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe_en
- European Commission. 2010. *International Science & Technology Specialisation: Where Does Europe Stand?* Luxembourg: DG-Research, Publications Office of the European Union.
- European Commission. 2011. *Cohesion Policy 2014-2020: Investing in Growth and Jobs*. Luxembourg: DG-Regional Policy, Publications Office of the European Union.
- European Parliament 2022. | Fact Sheets on the European Union | European Parliament. <https://www.europarl.europa.eu/factsheets/en/sheet/67/innovation-policy>. Accessed 15 June 2022.
- Eurostat (2022). High-tech industry and knowledge-intensive services. Annex 3 - High-tech aggregation by NACE Rev.2.
- Fagerberg, J. and Verspagen, B., 1996. Heading for divergence? Regional growth in Europe reconsidered. *JCMS: Journal of Common Market Studies*, 34(3), pp.431-448.
- Fagerberg, J. and Verspagen, B., 2002. Technology-gaps, innovation-diffusion and transformation: an evolutionary interpretation. *Research policy*, 31(8-9), pp.1291-1304.
- Goolsbee, Austan. 1998. 'Does Government R&D Policy Mainly Benefit Scientists and Engineers?' *American Economic Review* 88 (2): 298-302.
- Grech, A., 2019. SMEs as drivers of economic growth: The case of Malta, Central Bank of Malta.
- Greunz, L., 2003. Geographically and technologically mediated knowledge spillovers between European regions. *The Annals of Regional Science*, 37(4), pp.657-680.
- Griffith, R., Huergo, E., Mairesse, J., & Peters, B. (2006). *Innovation and productivity across four European countries*. Oxford review of economic policy, 22(4), 483-498.
- Griliches, Zvi. "Issues in assessing the contribution of research and development to productivity growth." *The bell journal of economics* (1979): 92-116.
- Grossman, Gene, and Elhanan Helpman. 1991. *Innovation and Growth in the Global Economy*. Cambridge MA: MIT Press.

- Hall, Bronwyn H., Francesca Lotti, and Jacques Mairesse. "Innovation and productivity in SMEs: empirical evidence for Italy." *Small business economics* 33.1 (2009): 13-33.
- Halme, Minna, and Maria Korpela. "Responsible innovation toward sustainable development in small and medium-sized enterprises: A resource perspective." *Business Strategy and the Environment* 23.8 (2014): 547-566.
- Haltiwanger, J., Jarmin, R.S. and Miranda, J., 2013. Who creates jobs? Small versus large versus young. *The Review of Economics and Statistics*, 95(2), pp.347-361.
- Hanson, P., Hanson, P., & Pavitt, K. (2013). *The Comparative Economics of Research Development and Innovation in East and West*. Routledge. [GET]
- Henderson, J. and Thisse, J., 2004. *Handbook of regional and urban economics*. Volume 4. Amsterdam: Elsevier North Holland.
- Hunt, Jennifer, and Marjolaine Gauthier-Loiselle. 2010. 'How Much Does Immigration Boost Innovation?' *American Economic Journal: Macroeconomics* 2 (2): 31-56.
- InnovFin. (n.d.). EU Funding Overview. Retrieved June 21, 2022, from <https://eufundingoverview.be/funding/innovfin-eu-finance-for-innovators-initiative-launched-by-the-european-investment-bank-group-eib-and-eif#:~:text=%22InnovFin%20%E2%80%93%20EU%20Finance%20for%20Innovator%20and%20other%20innovative%20entities%20in%20Europe>.
- Jaffe, A. B., (1989), Real effects of academic research, *American Economic Review* 79, 957-970.
- Jain, R., Triandis, H. C., & Weick, C. W. (2010). *Managing research, development and innovation: Managing the unmanageable* (Vol. 34). John Wiley & Sons. [GET]
- Jacob, Brian, and Lars Lefgren. 2011. 'The Impact of Research Grant Funding on Scientific Productivity.' *Journal of Public Economics* 95 (9-10): 1168-77.
- Janeway, William. 2012. *Doing Capitalism in the Innovation Economy: Markets, Speculation and the State*. Cambridge, UK: Cambridge University Press.
- Kerr, Sari, and William Kerr. 2020. 'Immigration Policy Levers for US Innovation and Startups.' Unpublished, Harvard University, Cambridge, MA.
- Kerr, William, and William Lincoln. 2010. 'The Supply Side of Innovation: H-1B Visa Reforms and U.S. Ethnic Invention.' *Journal of Labor Economics* 28 (3): 473-508.
- Komlos, J., 2016. Has creative destruction become more destructive?. *The BE Journal of Economic Analysis & Policy*, 16(4).
- Krugman, Paul, 1991. "Increasing Returns and Economic Geography," *Journal of Political Economy*, University of Chicago Press, vol. 99(3), pages 483-499, June.
- Lucking, Brian, Nicholas Bloom, and John Van Reenen. 2019. 'Have R&D Spillovers Changed?' *Fiscal Studies* 40 (4): 561-90.
- Litosseliti, L. (2003). *Using focus groups in research*. A&C Black.
- Lu, Y., 2017. Industry 4.0: A survey on technologies, applications and open research issues. *Journal of industrial information integration*, 6, pp.1-10.
- Maddikunta, P.K.R., Pham, Q.V., Prabadevi, B., Deepa, N., Dev, K., Gadekallu, T.R., Ruby, R. and Liyanage, M., 2022. Industry 5.0: A survey on enabling technologies and potential applications. *Journal of Industrial Information Integration*, 26, p.100257.
- Meliciani, V., 2016. *Regional disparities in the enlarged European Union: Geography, Innovation and Structural Change*. 1st ed. London: Routledge.
- Mendez, R., 2002. Creative destruction and the rise of inequality. *Journal of Economic Growth*, 7(3), pp.259-281.
- Moreno, R., Paci, R. and Usai, S., 2005a. Geographical and sectoral clusters of innovation in Europe. *The annals of regional science*, 39(4), pp.715-739.
- Moreno, R., Paci, R. and Usai, S., 2005b. Spatial spillovers and innovation activity in European regions. *Environment and planning A*, 37(10), pp.1793-1812.

Moreno, R., Paci, R. and Usai, S., 2006. Innovation clusters in the European regions. *European Planning Studies*, 14(9), pp.1235-1263.

Moretti, Enrico, and Daniel J. Wilson. 2017. 'The Effect of State Taxes on the Geographical Location of Top Earners: Evidence from Star Scientists.' *American Economic Review* 107 (7): 1858-903.

Moretti, Enrico, Claudia Steinwender, and John Van Reenen. 2019. 'The Intellectual Spoils of War? Defense R&D, Productivity and International Technology Spillovers.' Working Paper 26483, National Bureau of Economic Research, Cambridge, MA.

Moser, Petra, and Shmuel San. 2019. 'Immigration, Science, and Invention: Evidence from the 1920s Quota Acts.' Unpublished, New York University, New York, NY.

Moser, Petra, Alessandra Voena, and Fabian Waldinger. 2014. 'German Jewish ...Émigrés and US Invention.' *American Economic Review* 104 (10): 3222-55

Nahavandi, S., 2019. Industry 5.0-A human-centric solution. *Sustainability*, 11(16), p.4371.

OECD/Eurostat., 2018., Oslo Manual 2018: Guidelines for Collecting, Reporting and Using Data on Innovation, 4th Edition, The Measurement of Scientific, Technological and Innovation Activities, OECD Publishing, Paris/Eurostat, Luxembourg. <https://doi.org/10.1787/9789264304604-en>

Noor, K. B. M. (2008). Case study: A strategic research methodology. *American journal of applied sciences*, 5(11), 1602-1604.

O'Grady, M and Gownder, J.P. 2022. Future Of Jobs Forecast, 2020 To 2040 (Europe-5) Balanced Regional Tech Strategies, Workforce Upskilling, And Green Jobs Mitigate Some Jobs Losses. Forrester.

Porter, M, 2004. Global Competitiveness Report 2003-2004, New York: World Economic Forum

Porter, M., 1990. Competitive advantage of nations. United States of America: Free Press.

Rao, Nirupama. 2016. 'Do Tax Credits Stimulate R&D Spending? Revisiting the Effect of the R&D Tax Credit in Its First Decade.' *Journal of Public Economics* 140 (C): 1-12.

Rodríguez-Pose, A. and Crescenzi, R., 2008. Research and development, spillovers, innovation systems, and the genesis of regional growth in Europe. *Regional studies*, 42(1), pp.51-67.

Romer, P.M., 1990. Endogenous technological change. *Journal of political Economy*, 98(5, Part 2), pp.S71-S102.

Roulston, K., & Choi, M. (2018). Qualitative interviews. *The SAGE handbook of qualitative data collection*, 233-249.

Sala-i-Martin, XX, 1996. Regional cohesion: evidence and theories of regional growth and convergence. *European economic review*, 40(6), pp.1325-1352.

Schumpeter, J., 1942. *Capitalism, Socialism and Democracy*. Harper & Brothers. London: Routledge.

Sengupta, J., 2014. Theory of innovation: A new paradigm of growth. In *Theory of Innovation* (pp. 1-25). Springer, Cham.

Singh, J., 2005. Collaborative networks as determinants of knowledge diffusion patterns. *Management science*, 51(5), pp.756-770.

Smithson, J. (2000). Using and analysing focus groups: limitations and possibilities. *International journal of social research methodology*, 3(2), 103-119.

Shu, Pian, and Claudia Steinwender. 2018. 'The Impact of Trade Liberalization on Firm Productivity and Innovation.' Working Paper 24715, National Bureau of Economic Research, Cambridge, MA.

Solheim, M. C., Boschma, R., & Herstad, S. J. (2020). Collected worker experiences and the novelty content of innovation. *Research Policy*, 49(1), 103856. [GET]

Solow, R.M. (1957) Technical change and the aggregate production function. *Review of Economics and Statistics* 39: 312-320

Tongco, M. D. C. (2007). Purposive sampling as a tool for informant selection.

Van Reenen, John. 2011. 'Wage Inequality, Technology and Trade: 21st Century Evidence.' *Labour Economics* 18 (6): 730-41.

Van Reenen, John. "Innovation policies to boost productivity." *The Hamilton Project*, Brookings Institution, Washington, DC (2020).

Varga, A., Anselin, L. and Acs, Z. 2005. "Regional innovation in the US over space and time". In *Spillovers and Innovation: Space, Environment and the Economy*, Edited by: Maier, G. and Sedlacek, S. Vienna: Springer-Verlag.

Verspagen, B., 1997. Uneven growth between interdependent economies: an evolutionary view on technology gaps, trade and growth. Aldershot: Avebury.

Von Hippel, E., 1994. "Sticky information" and the locus of problem solving: implications for innovation. *Management science*, 40(4), pp.429-439.

Wilson, Daniel J. 2009. 'Beggar Thy Neighbor? The In-State, Out-Of-State and Aggregate Effects of R&D Tax Credits.' *Review of Economics and Statistics* 91 (2): 431-36.

Wu, D. D., Kefan, X., Hua, L., Shi, Z., & Olson, D. L. (2010). Modeling technological innovation risks of an entrepreneurial team using system dynamics: an agent-based perspective. *Technological Forecasting and Social Change*, 77(6), 857-869. [GET]

Xu, L.D., 2020. Industry 4.0-Frontiers of fourth industrial revolution. *Systems Research and Behavioral Science*, 37(4), pp.531-534.

Zucker, L.G., Darby, M.R. and Armstrong, J., 1994. Intellectual capital and the firm: The technology of geographically localised knowledge spillovers.

Appendix II

INTERVIEW QUESTIONS

QUESTIONNAIRE

1) Please specify your full name, title, your organization, and any other professional affiliations and kindly indicate whether you wish to be listed in the list of members consulted in relation to the Drafting of the National Productivity Board Annual Report 2022.

2) Do you have research and development projects currently underway in your firm or planned over the coming year? Are you aware of any such projects within your sector?

3) If no, kindly skip this question. If yes - is the focus on innovations related to the way products or services are created, the way that products/services are delivered (both may include new technologies, skills to enhance productivity or structures - e.g. digitalisation), new products or services, innovative business models, innovative marketing, or green investments?

4) Do employees in your establishment document and keep records of their good work practices or lessons learned, with the purpose to share these with other employees? (Yes/No)

5) Does your establishment monitor external ideas or technological developments for new or changed products, processes or services? (Select one)

- i. Yes, using staff assigned specifically to this task
- ii. Yes, as part of the responsibilities of general staff
- iii. No

Please put forward any further comments to this question:

6) Please rank the following factors, with 1 being 'Very Low' and 8 being 'Very High', on the extent to which they facilitate your ability to undertake research and development and initiate innovative projects? Please comment on your top three factors.

Knowledge and skills of existing workforce	<input type="text"/>
Forward-looking leadership	<input type="text"/>
Favourable government policy	<input type="text"/>
Availability of public funding	<input type="text"/>
Keeping up with competition in Malta and abroad	<input type="text"/>
Desire to export	<input type="text"/>
Innovation can help to reduce business costs	<input type="text"/>
Rapidly changing business environment	<input type="text"/>

Please comment on your top **three** factors:

7) Please rank the following factors, on a scale from 1 to 10, with 1 being 'Very Low' and 10 being 'Very High', to what extent do these factors limit your ability to undertake research and development and initiate innovative projects? Please comment on your top three factors.

Lack of internal finance	<input type="text"/>
Lack of external finance (credit or private equity)	<input type="text"/>
High costs	<input type="text"/>
Lack of qualified employees within the organization	<input type="text"/>
Lack of collaboration partners	<input type="text"/>
Difficulties in obtaining public grants or subsidies	<input type="text"/>
Uncertain market demand	<input type="text"/>
High competition	<input type="text"/>
Lack of access to external knowledge	<input type="text"/>
Different priorities within the organization	<input type="text"/>

Please comment on your top **three** factors:

8. In your view what can be done at both the national and EU level in order to encourage greater R&D spending and innovation in your sector?

[Please consider the following factors: Malta's educational system, EU funding and collaborations, role of the National Development Bank, the role of research institutions like the University of Malta and the establishment of a public research centres for specific areas such as like Machine Learning]

9. Are there any specific noteworthy success stories which highlight the drive for innovation and R&D within your sector or within your company?



