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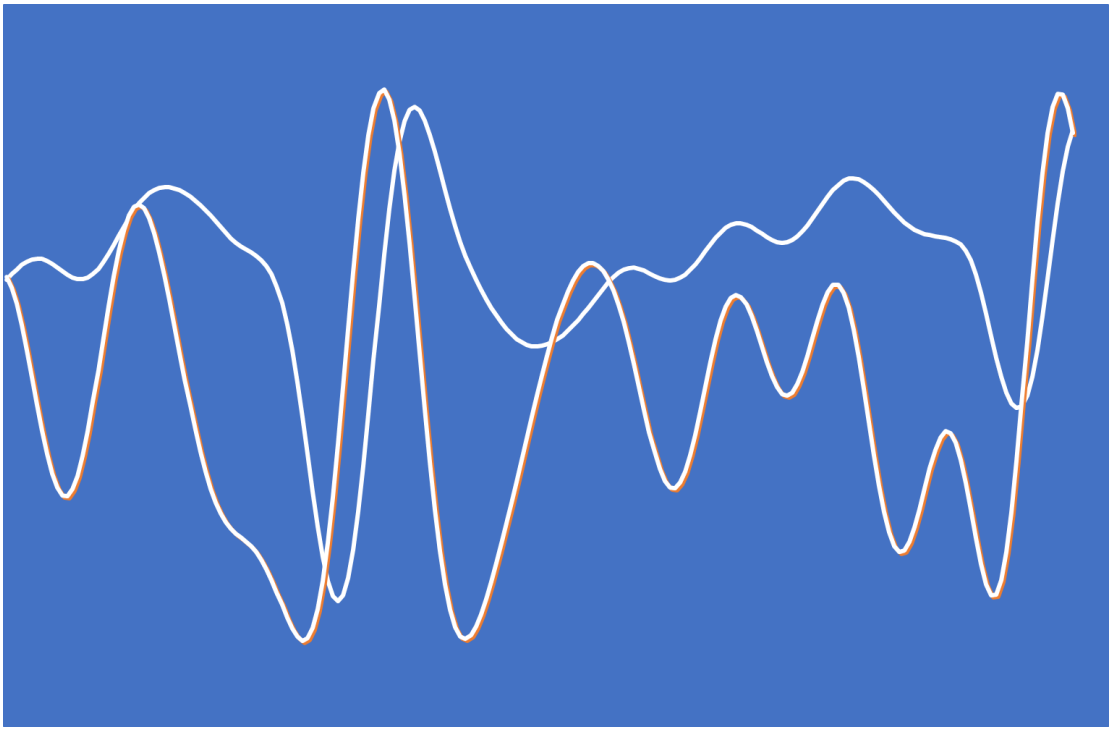
Leading indicators for IPR-intensive industries



November 2021

LEADING INDICATORS FOR IPR-INTENSIVE INDUSTRIES

THE VIEWS EXPRESSED IN THIS DISCUSSION PAPER DO NOT REPRESENT THE OFFICIAL POSITION OF THE EUIPO

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Abstract

The economic impact of the COVID-19 crisis on industries that intensively use different intellectual property rights (IPRs) has been analysed in a previous EUIPO discussion paper. Five different IPR indicators have been estimated to monitor the short-term trend of all IPRs, trade marks (TM), designs (DES), patents (PT) and copyright (CR). The indicators have been estimated for the EU as well as the four largest Member States.

In June and September 2021, the EUIPO published two updates of the IPR indicators, including data for the first and second quarters of 2021, showing an incipient recovery. Nevertheless, the indicators were still below their pre-crisis level.

This paper presents leading indicators that provide early signs of the future trends of IPR-intensive industries. They do not allow the forecasting of the expected value of the IPR indicators in future months, but they show when the indicators will change from an acceleration to a deceleration phase (or vice versa) with up to 7 months of advance.

In EUIPO (2021a), the analysis of the economic impact of the COVID-19 crisis on IPR-intensive industries was based on the size of the recession and recovery phases' annual rates of change. In contrast, this paper focuses on the timing of those phases and the number of industries trending upward in each month to complement the previous analysis. The dates when the maximum or minimum rates are reached (peaks and troughs) are analysed and the leading indicators proposed anticipate changes in the trends of the IPR-intensive industries.

In summary, the previous analysis of the magnitude of the impact of the COVID-19 crisis on IPR-intensive industries is now complemented with evidence about the scope of economic recession and recovery phases.

JEL: O34, 047, O52
Keywords: Intellectual Property, diffusion indices, leading indicators, EU economy

1 Introduction

The analysis of the economic impact of the COVID-19 crisis on the IPR-intensive industries in the European Union (EU) can be done based on Eurostat's short term business statistics (STS).

In a previous paper ([1]), the EUIPO has presented indicators for the IPR-intensive industries ([2]) and separately for some specific IPRs, including trade marks (TM), designs (DES), patents (PT) and copyright (CR). These indicators allow the monitoring of the economic trends of IPR-intensive industries in the EU, France and Spain, as well as some limited indicators for Germany and Italy.

In this paper, the EUIPO presents a set of diffusion indices for the IPR indicators that anticipate changes in their cyclical phases. An acceleration, recovery or expansion phase is defined here as a period when the annual growth rates of change are increasing, meaning that the annual growth rate in the current month, compared with the same month of the previous year, is higher than the rate of change of the previous month. Consequently, a deceleration or recession phase occurs when the annual growth rate of a month is decreasing, so that it is lower than the annual growth rate of the previous month. Therefore, an acceleration or deceleration phase does not imply that the growth rates are positive or negative, instead they are defined according to the growth trend of each month.

Section 2 presents an introduction to diffusion indices, the methodology of which is explained in more detail in the appendix. These indices look for early signs about future developments in IPR-intensive industries that will allow a quicker reaction to changes in their trends. Section 3 presents the results for different IPR indicators in the EU. Section 4 summarises results for the four largest Member States and Section 5 presents the main conclusions.

([1]) EUIPO (2021a).

([2]) Following EUIPO/EPO (2019), the IPR-intensive industries refer to industries that are intensive in the use of trade marks, designs, patents, and copyright, as well as geographical indications (GIs) and plant variety rights (PVR).

2 Diffusion indices

One of the fundamental characteristics of the economy is that economic movements spread from one firm to another, from one industry to another, from one region to another and these spreading movements accumulate over time. It is desirable to have a measure of how this spreading and accumulation is evolving, and diffusion indices are one such measure.

The rate of change of an aggregate cannot give a measure of this spreading process, because it is independent on the economic units into which it can be divided. The IPR-intensive industries are defined in the EUIPO/EPO (2019) report and are based on the industries that use more IPRs than the average. The indicators used for monitoring their activity are defined in EUIPO (2021a) and are based on detailed data on most of the three hundred industries classified as IPR-intensive. The diffusion indices presented in this paper use as economic units or component series the industries among which the spreading and cumulation of economic change occurs and as aggregates the IPR-intensive industries indicators.

Diffusion indices are a type of synthetic indicator used for short-term analysis that summarise information on the components of an aggregate which are the economic units whose activity is added up to form the aggregates. They are used for the monitoring of employment, the stock market or to analyse several business cycle indicators. The original concept of diffusion indices was presented in the 1950s ([3]) as an aid to identifying the turning points in business cycles. Several papers from the National Bureau of Economic Research (NBER) show the use of those indices in the second half of the 20th century. A few of the most relevant ones are included in the References section.

The diffusion indices published by the NBER are used as a barometer of the United States economy, and use a wide range of economic indicators. Alternatively, diffusion indices published by other statistical offices, such as the Spanish Instituto Nacional de Estadística (INE) and the Instituto Galego de Estatística (IGE), anticipate future employment trends by using the industrial employment component series at a very detailed level. This paper presents diffusion indices for the IPR-intensive industries indicators using as components in their construction all the STS series with complete data.

([3]) Moore, G.H. (1950)

Diffusion indices aggregate multiple indicators by examining whether they are trending upward or downward. However, they ignore the magnitude of the movement. A diffusion index is then a statistical measure often used to detect economic turning points, which are the points where the series moves from an acceleration phase to a deceleration one (peak) or vice versa (trough). A peak is then the last period of an expansion, while a trough is the last period of a recession.

Based on Moore (1961), diffusion indices have two uses: i) they measure the dispersion of the aggregate, which is important to determine when a turning point is reached, and ii) they are leading economic indicators. The use of diffusion indices for business forecasting is discussed in Moore (1961) and backed by NBER experience, based on two empirical pieces of evidence: '(1) cyclical expansions or contractions in aggregate activity diminish in scope before they come to an end; (2) contractions that ultimately become severe are widespread in their early stages'.

The diffusion index in a moment t is defined as the percentage of time series of the aggregate that are trending upward in this period. The index takes values between 0 and 1. Therefore, the diffusion index measures the extension of the acceleration or recovery process of the component series. An index close to 1 indicates an increase of the growth rate of most of the series, while an index close to 0 is the consequence of a general slowdown of the aggregate index component series. A recovery (or recession) phase can be caused by increases (or decreases) in only a few industries or by more widespread increases (or decreases) and this has policy implications which are different in both cases. This is why the use of a large number of series is essential in the construction of diffusion indices, as well as, whenever possible, the use of series of similar size when the components are the detailed employment or production series, as is the case with the diffusion indices of the IPR indicators presented in this paper. When the component series used are of different magnitudes, a weighted diffusion index can be proposed ([4]).

Each series ([5]) is first classified based on the analysis of turning points into either leading, lagging, coincident or acyclic series in relation to the reference series (the IPR indicator). There is no general agreement about the exact lead time determined for coincident series. The three examples mentioned before (NBER, INE and IGE) consider the median lead time interval [-3,3] to classify series as coincident with median lead time higher than 3 resulting in leading when it is negative and

([4]) Arias (1997).

([5]) All series are previously filtered to eliminate noise and irregular movements. The diffusion indices are composed of the SAR of all the series, as explained in the appendix.

lagging if positive. Other institutions, such as the OECD, recommend an interval of [-2,2] for coincident series, while Eurostat simply considers leading indicators as those that change before the reference series. Here, a series is classified as a leading indicator when it anticipates the turning points of the reference series by a median of more than 3 months. Acyclic series are those with any conformity ratio ([6]) below 0.6.

As explained in the appendix, diffusion indices will be leading indicators of the aggregate independently of the distribution of the components in leading, coincident and lagging, provided that there are series of all three types in the index. A higher proportion of leading series will influence the rhythm of variation of the index and its variance. Finally, the presence of acyclic series can distort the relation of the index with the aggregate.

The appendix shows the classification of the component series with regards to each of the IPR indicators. The EU indicators for all IPRs, trade marks and patents have a similar share of leading indicators, between five and eight and representing about 5 % of the Value Added (VA) of the corresponding indicator. The design indicators only have 3 out of 104 series classified as leading, while the copyright indicator has only 2.

The copyright indicator includes only 20 series, 2 of which are classified as leading series and 17 which are classified as coincident. The low coverage of the series in the service sector and their excessive aggregation level (NACE[7] divisions) result in a very small number of series. This makes it difficult to consider them a reliable source to anticipate movements in these industries. Therefore, no diffusion index is proposed for the copyright-intensive industries and the rest of this paper limits the analysis to the other IPR indicators: all IPRs, trade marks, designs and patents.

The indicators for the four Member States (MS) show a different classification of the series. France has more than 10 % of leading indicators in the four IPR indicators or between 10 and 30 leading series in the patent and IPR indicators respectively. Spain has more than 10 leading series in all indicators except the design indicator which has only 4 % of leading series. German and Italian

([6]) Conformity ratios are defined as the number of paired turning points divided by the total number of turning points of the reference series (IPR indicator) and divided by the total number of turning points of the component series.

[7] NACE is the official classification system of economic activity used in the EU.

indicators for patents and designs have fewer leading indicators, with about 5 % of leading series in Germany and only two leading series in the Italian patent indicator.

3 Diffusion indices for the EU IPR-intensive industries

This section analyses the following four IPR indicators for the EU: IPRs, trade marks, designs and patents.

Each IPR indicator is composed of a different list of industries. These are first analysed to check whether they allow the construction of reliable diffusion indices. Then the diffusion indices are compared with the IPR indicators, taking into consideration the dates of the turning points and the value of the indices reflecting the extension of the acceleration or recession phases.

3.1 IPR diffusion indices

The IPR indicator for the EU is composed of 147 STS series with data taken from the period January 2001 to June 2021. This is sufficient to estimate a diffusion index. Due to the different levels of detail available for the manufacturing, wholesale trade and service sectors' indices ([8]), the economic importance of these series, measured by their VA, ranges between 0.005 % (NACE class 1439) and 7.5 % (NACE division 62) ([9]). To take this uneven size of the component series into account, a weighted diffusion index is estimated, which takes into consideration the weights applied for the construction of the IPR indicator ([10]).

([8]) The IPR indicator is composed by seasonal and calendar adjusted STS series including 130 production indices in manufacturing at NACE class (4-digit) level; 8 turnover indices at NACE group (3-digit) level in the wholesale sector and 9 turnover indices at NACE division level (2-digit) for the service sector.

([9]) NACE 1439 'Manufacture of other knitted and crocheted apparel' and NACE 62 'Computer programming, consultancy and related activities'.

([10]) As explained in EUIPO (2021a), the weights combine the Gross Value Added (GVA) from the IP contribution report, 3rd edition and the VA of each class/group/division from the Structural Business Survey (SBS) 2015.

For the cyclical classification of the component series, all their turning points are paired off with one and just one turning point of the IPR indicator. The series compared usually have a different number of turning points so that some of them might not have a corresponding pair. For each component series two conformity ratios are defined: one as the number of paired turning points divided by the total number of turning points of the reference series (IPR indicator) and the other as the number of paired turning points divided by the total number of turning points of the classified series. The minimum conformity ratio is fixed at 0.6 so that all component series with lower ratios are classified as acyclic.

For those series with a conformity ratio of at least 0.6, the lead time is defined as the distance in months between paired turning points and it is used to determine whether the series is coincident (between 0 and 3 months of median lead time), leading (when the median lead time of turning points is more than 3 months) or lagging (median delay of more than 3 months).

Seven out of eight leading series in the IPR indicator are in the manufacturing sector, and one is in the service sector, corresponding to NACE division 63 ([11]). Only one series is acyclic, the NACE class 1104 ([12]) which is TM intensive and 15 series are classified as lagging.

Based on the complete list of the component series, two diffusion indices have been estimated and their turning points compared with those of the IPR indicator. All turning points in the IPR indicator are flagged by the diffusion indices but there is one cycle in both diffusion indices between 2018 and 2019 that does not correspond with a cycle in the IPR indicator.

The median lead time ([13]) (with respect to the IPR indicator) for the Diffusion Index is -5 months and for the Weighted Diffusion Index it is -5.5 months. Therefore, both diffusion indices are classified as leading indicators.

([11]) NACE 63 ‘Information service activities’.

([12]) NACE 1104 ‘Manufacture of other non-distilled fermented beverages’.

([13]) Median lead times with negative values correspond to turning points anticipated by the diffusion index as a median, and positive values should imply a median delay flagging turning points of the reference series (IPR indicator).

Figure 1 shows the Smoothed Annual Rates (SAR) of the diffusion indices and the IPR indicator for the period January 2004 to June 2021.

Figure 1 IPR indicator and two diffusion indices (SAR)

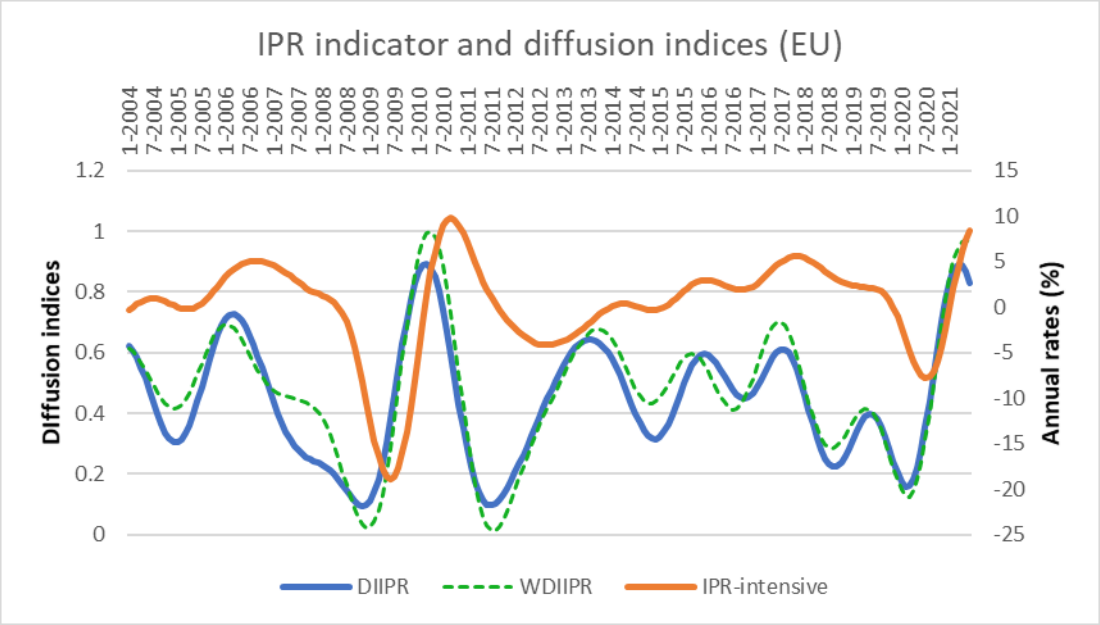


Table 1 shows the dates of all the turning points of the IPR indicator and both diffusion indices. Additionally, the dates of the peaks and troughs of both diffusion indices are compared with the corresponding turning points of the IPR indicator. The difference in months is shown in parentheses. Negative values correspond to turning points advanced by the diffusion index and positive values mean that the diffusion index flags this specific turning point with a delay.

The IPR indicator detected 12 turning points in the period analysed, all of them paired with the two diffusion indices. Both diffusion indices flagged the same 15 turning points with a maximum difference in dates between them of 3 months. This resulted in conformity ratios ([14]) of 1 for the reference series and 0.86 for both diffusion indices.

([14]) Conformity ratios are always calculated without considering the last peak of diffusion indices in 2021, as this still needs some months to have a paired peak in the IPR indicator.

Table 1 Turning points dates of IPR indicator and diffusion indices

IPR indicator		IPR Diffusion index		IPR Weighted Diffusion index	
Peak	Trough	Peak	Trough	Peak	Trough
07-2004	04-2005	12-2003 (-7)	01-2005 (-3)	12-2003 (-7)	12-2004 (-6)
08-2006	06-2009	03-2006 (-5)	11-2008 (-7)	01-2006 (-7)	12-2008 (-6)
09-2010	09-2012	03-2010 (-6)	07-2011 (-14)	04-2010 (-5)	08-2011 (-13)
04-2014	11-2014	08-2013 (-8)	12-2014 (+1)	10-2013 (-6)	11-2014 (0)
12-2015	09-2016	12-2015 (0)	10-2016 (+1)	09-2015 (-3)	07-2016 (-2)
11-2017	*	08-2017 (-3)	08-2018 (*)	07-2017 (-4)	08-2018 (*)
*	07-2020	05-2019 (*)	02-2020 (-5)	04-2019 (*)	03-2020 (-4)
*		03-2021 (*)		05-2021 (*)	

Notes: the difference between the date of the turning points of the diffusion indices and the IPR indicator is shown in parentheses. Negative values correspond to turning points anticipated by the diffusion index.

* no correspondence between IPR indicator and the diffusion indices

To decide which of the two diffusion indices is a better leading indicator for the IPR-intensive industries, the lead time of some turning points are compared. One peak in 2015 has been flagged by the Weighted diffusion index 3 months in advance compared to the IPR indicator, while the Diffusion Index coincides in the same month as the IPR indicator. Additionally, one trough in 2014 of the IPR indicator coincides with the Weighted Diffusion Index but it is flagged 1 month later by the Diffusion Index and another trough in 2016 is anticipated by 2 months by the Weighted Diffusion Index and delayed 1 month by the unweighted Diffusion Index. To conclude, the Weighted Diffusion Index is the preferred option based on the timing of the turning points and that the median lead time is slightly better.

Both diffusion indices detected an additional cycle between 2018 and 2019, while the IPR indicator just registered a flattening of the time series as this was not considered to be a new cycle. Due to the design of diffusion indices, which only contain information about the direction of the change but not the magnitude, it is possible that it overvalues recovery or acceleration processes. The index can start to show signs of a recovery when some series start to increase their growth rate without being subsequently reflected in an improvement of the aggregate. This is referred to as a frustrated

recovery process. This situation is more likely to happen the more the acceleration or recovery process is focused on some specific industries.

The last turning point in the diffusion indices is a peak dated in March and May 2021 that anticipates the end of the expansion phase of the IPR indicator by the end of 2021.

Alternative diffusion indices are proposed by Moore (1961) using the 'two-thirds criterion' for the selection of ideal component series. This criterion is used for the selection of revival indicators and then focuses only on troughs: 'a series was considered an acceptable indicator of revivals if its specific cycle troughs led the corresponding reference troughs at two-thirds or more of the reference troughs it covered; or if it was roughly coincident (turned within three months of the reference trough) at two-thirds or more of the troughs …'.

Based on Moore's two-thirds criterion, all component series of the IPR indicator are evaluated to estimate two diffusion indices that are now limited to those series considered acceptable only for troughs and also considering all turning points.

The IPR indicator flagged six peaks and six troughs in the period 2003 to June 2021. These are paired with turning points from all the component series. Among the 147 series included in this indicator, 18 have flagged all the turning points but none anticipated or coincided in all of them ([15]). Among these 18 series, one belongs to the wholesale sector (466 ([16])), and is selected based on the acceptability criterion only for troughs, and one belongs to the service sector (73 ([17])), and is not acceptable and therefore not included in the new diffusion indices. There are, nevertheless, eight series that have anticipated all the troughs with a maximum of 3-months delay, and all of them are in the manufacturing sector.

It is also important to highlight that only two ([18]) out of nine series in the service sector are selected (three of them were classified as lagging series) as well as half of the series in the wholesale sector.

([15]) A more detailed analysis of the 147 IPR-intensive industries, based on the two-thirds criterion is included in the appendix.
([16]) NACE 466 'Wholesale of other machinery, equipment and supplies'.
([17]) NACE 73 'Advertising and market research'.
([18]) NACE 59 'Motion picture, video and television programme production, sound recording and music publishing activities' and NACE 79 'Travel agency, tour operator reservation service and related activities'.

A total of 88 series (60 % of the available IPR-intensive industries) are now selected for the estimation of two new diffusion indices which are called Leading Diffusion Index (including only series that lead or coincide with the reference series) and Weighted Leading Diffusion Index, using the weights already explained. This method discards all the lagging series, some of the coincident series with have few turning points paired with the IPR indicator and even one leading series, division 61 ([19]), which was the only leading series in the service sector.

Table 2 shows the turning points dates for the Leading Diffusion Indices and their lead periods in relation with the IPR indicator.

Table 2 Turning points dates of IPR indicator and leading diffusion indices

IPR indicator		IPR Leading Diffusion index		IPR Weighted Leading Diffusion index	
Peak	Trough	Peak	Trough	Peak	Trough
07-2004	04-2005	01-2004 (-6)	12-2004 (-4)	11-2003 (-8)	12-2004 (-4)
08-2006	06-2009	02-2006 (-6)	11-2008 (-7)	01-2006 (-7)	11-2008 (-7)
09-2010	09-2012	02-2010 (-7)	06-2011 (-15)	03-2010 (-6)	06-2011 (-15)
04-2014	11-2014	05-2013 (-11)	09-2014 (-2)	04-2013 (-12)	08-2014 (-3)
12-2015	09-2016	09-2015 (-3)	07-2016 (-2)	07-2015 (-5)	06-2016 (-3)
11-2017	*	06-2017 (-5)	07-2018 (*)	05-2017 (-6)	07-2018 (*)
*	07-2020	05-2019 (*)	02-2020 (-5)	06-2019 (*)	03-2020 (-4)
		03-2021 (*)		04-2021 (*)	

Note: the difference between the date of the turning points of the diffusion indices and the IPR indicator is shown in parentheses. Negative values correspond to turning points anticipated by the diffusion index.
* no correspondence between IPR indicator and the diffusion indices

All the turning points coincide or are anticipated by the leading diffusion indices compared with the corresponding diffusion index ([20]) which has been estimated using all the series. This can be checked by comparing dates in Table 1 and Table 2. Additionally, none of the turning points have been

([19]) NACE 61 'Telecommunications'.
([20]) The Leading Diffusion Index is compared with the Diffusion Index and the Weighted Leading Diffusion Index is compared with the Weighted Diffusion Iindex.

flagged with a delay by these new diffusion indices. This results in median lead times of advance of 5 months for the Leading Diffusion Index and 6 months for the Weighted Leading Diffusion Index.

The four diffusion indices are shown in Figure 2, while Figure 3 shows the turning points of the IPR indicator and the Weighted Leading Diffusion Index with labels indicating the lead period for each paired turning point.

Figure 2 IPR indicator and diffusion indices (SAR)

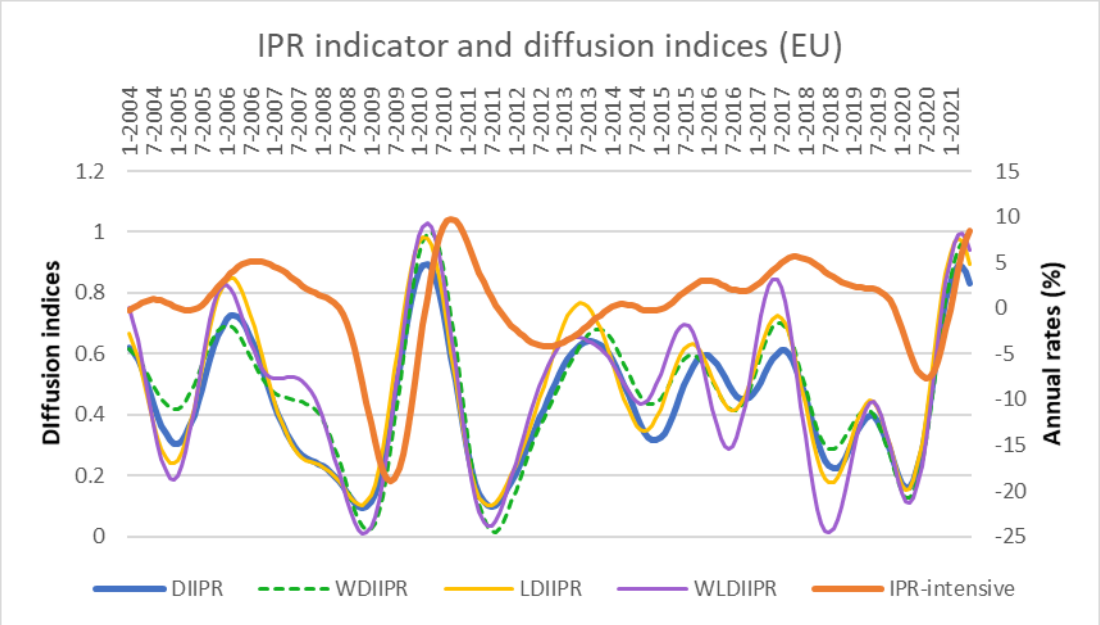
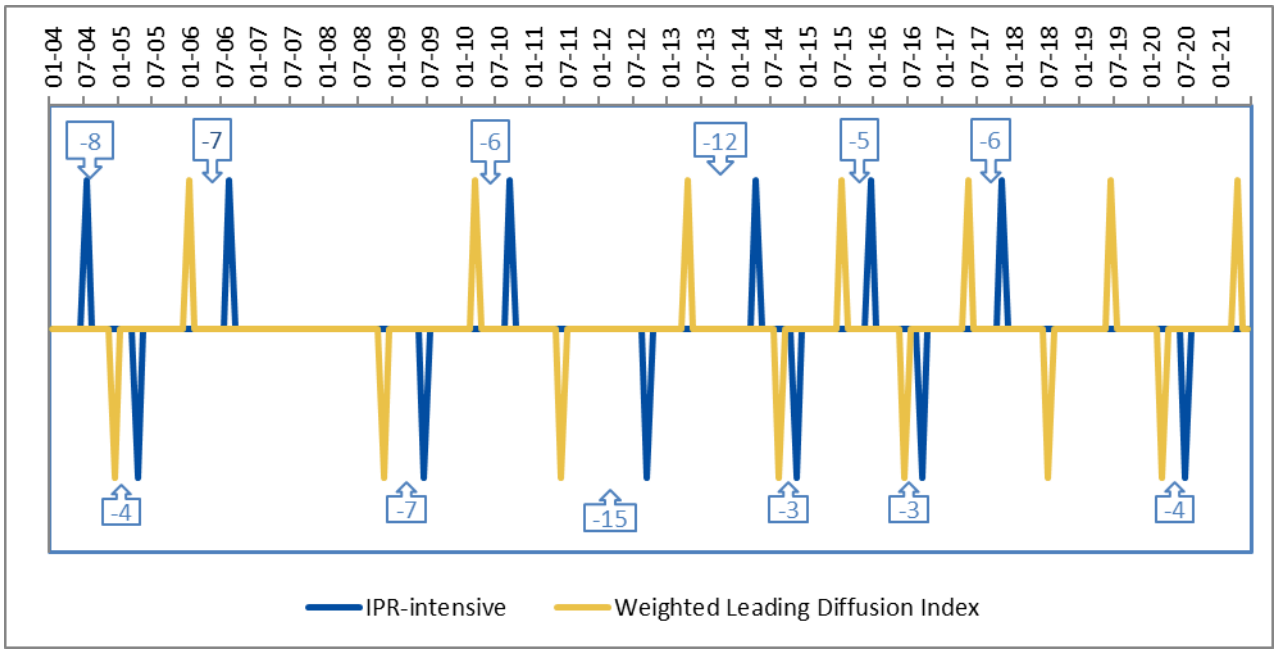


Figure 3 IPR indicator and Weighted Leading Diffusion Index turning points and lead periods (months)



As mentioned before, diffusion indices have two uses. One use is to be leading economic indicators and this has been proved before based on the dates and cyclical classification of turning points.

The other use is to measure the dispersion of the aggregate that will be analysed based on Figure 2 to understand whether different recessions are the result of a widespread downturn in most of the industries or only a decline in just a few industries.

The trough, dated in July 2020 in the IPR indicator with annual rates of -7 % in the period June-September, was anticipated by the four diffusion indices. When all 147 series are considered, the minimum was reached in February when only 8 % of the series were trending upward, which represented a similar share of the VA generated by IPR-intensive industries. A slightly smaller value was reached by the selected list of leading series but they represented only 4 % of the VA generated by the leading series.

In February 2020, there were only 13 series trending upward, including one in the wholesale sector (465), one in the service sector (61) and two in mining (0891 and 0893). In the recovery phase, from

January to April 2021, until 139 out of 147 series are trending upward and less than 10 series are trending downward with the highest value of the diffusion indices and same value than during the recovery phase at the end of 2009.

The current situation is also compared with the 2009 financial crisis. In the 2009 trough less than 5 % of the series increased their rates and these represented less than 1 % of the VA of the IPR-intensive industries included in the indicator and an even lower percentage when limited to just the leading series. More precisely, a total of eight industries were trending upward, all of them in manufacturing and none with a weight higher than 1 % of the VA of the IPR-intensive industries. This confirms that the 2009 recession in IPR-intensive industries was more pronounced and more widespread than the 2020 crisis.

In conclusion, all the diffusion indices provide relevant information: the unweighted indices show whether the recession is widespread among IPR-intensive industries or whether it is concentrated in some of them and the weighted diffusion indices value reflects the economic importance of those industries. Additionally, the leading diffusion indices are important to provide early signs of turning points in the IPR-intensive industries with a median of 6 months of advance notice. The complete set of four diffusion indices has been estimated for the three individual IPR indicators: trade marks, designs, and patents and the results are presented in the rest of Section 3.

3.2 Trade mark diffusion indices

The trade mark indicator is composed of 117 STS series with complete data, of which 7 are leading series, 8 are lagging and 4 are acyclic (any conformity ratios below 0.6). This is the indicator with most acyclic series and which could distort the cyclical relation of the diffusion indices and the trade mark indicator. The share of leading series is similar to the IPR indicator.

These series allow the estimation of a Diffusion Index and a Weighted Diffusion Index to take into account the different VA of the component series ranging from 0.008 % to 7.3 % ([21]).

([21]) The two series with higher weights are NACE 2910 ‘Manufacture of motor vehicles’ with a weight of 7.3 % and 1920 ‘Manufacture of refined petroleum products’ with a weight of 7 %.

The dates of all turning points flagged in the trade mark indicator and the two diffusion indices are shown in Table 3, with the difference in months between paired turning points in parentheses.

Table 3 Turning points dates of trade mark indicator and diffusion indices

TM indicator		TM Diffusion index		TM Weighted Diffusion index	
Peak	Trough	Peak	Trough	Peak	Trough
*	*	12-2003 (*)	01-2005 (*)	12-2003 (*)	12-2004 (*)
08-2006	06-2009	03-2006 (-5)	11-2008 (-7)	01-2006 (-7)	12-2008 (-6)
09-2010	10-2012	03-2010 (-6)	07-2011 (-15)	04-2010 (-5)	07-2011 (-15)
02-2014	11-2014	06-2013 (-8)	11-2014 (0)	10-2013 (-4)	11-2014 (0)
*	*	11-2015 (*)	09-2016 (*)	08-2015 (*)	06-2016 (*)
10-2017	11-2018	07-2017 (-3)	08-2018 (-3)	05-2017 (-5)	07-2018 (-4)
07-2019	07-2020	05-2019 (-2)	02-2020 (-5)	04-2019 (-3)	02-2020 (-5)
		04-2021 (*)		04-2021 (*)	

Note: the difference between the date of the turning points of the diffusion indices and the IPR indicator is shown in parentheses. Negative values correspond to turning points anticipated by the diffusion index.
* no correspondence between IPR indicator and the diffusion indices

The trade mark indicator flagged 10 turning points. Comparing the trade mark indicator with the IPR indicator, there is an extra cycle flagged between 2018-2019 in the trade mark indicator and an extra cycle flagged between 2015-2016 in the IPR indicator.

All the turning points are paired with the diffusion indices, which have four extra turning points shown with asterisks in Table 3. This results in conformity ratios of 1 and 0.71. The turning points of the trade mark diffusion indices coincide with the IPR diffusion indices or are flagged one month before. All diffusion indices have already flagged a peak in April 2021 anticipating the end of the recovery phase in late 2021.

The Diffusion Index anticipates the trade mark indicator's turning points in all cases except for one that coincides with the Weighted Diffusion Index. The median lead time of all paired turning points is -5 months for both diffusion indices.

The leading diffusion indices presented in Table 4 are built using only series that are considered acceptable based on the two-thirds criterion. A total of 98 out of 117 trade mark intensive industries are included. This represents 84 % of all the available series. Due to the higher coverage of the leading series, it is likely that the leading diffusion indices are more similar to the diffusion indices with all the series than in the case of the IPR indicator diffusion indices. All lagging series but one are discarded and the four acyclic series are kept in the Leading Diffusion Indices ([22]). As in the case of diffusion indices with all the component series, a weighted index is also estimated.

The cyclical relation of the component series of the trade mark indicator is very good. There are 49 series that detect all the turning points of the trade mark indicator and 2 of them do so with a maximum of 3-month delay ([23]) for all turning points.

Table 4 Turning points dates of trade mark indicator and leading diffusion indices

TM indicator		TM Leading Diffusion index		TM Weighted Leading Diffusion index	
Peak	Trough	Peak	Trough	Peak	Trough
*	*	12-2003 (*)	01-2005 (*)	1-2003 (*)	01-2005 (*)
08-2006	06-2009	04-2006 (-4)	10-2008 (-8)	02-2006 (-6)	12-2008 (-6)
09-2010	10-2012	02-2010 (-7)	07-2011 (-15)	03-2010 (-6)	07-2011 (-15)
02-2014	11-2014	08-2013 (-6)	12-2014 (+1)	10-2013 (-4)	11-2014 (0)
*	*	11-2015 (*)	09-2016 (*)	09-2015 (*)	07-2016 (*)
10-2017	11-2018	07-2017 (-3)	08-2018 (-3)	05-2017 (-5)	06-2018 (-5)
07-2019	07-2020	05-2019 (-2)	02-2020 (-5)	04-2019 (-3)	02-2020 (-5)
*		04-2021 (*)		04-2021 (*)	

Note: the difference between the date of the turning points of the diffusion indices and the IPR indicator is shown in parentheses. Negative values correspond to turning points anticipated by the diffusion index.

* no correspondence between IPR indicator and the diffusion indices

([22]) The two-third criterion compares the number of leading and coincident turning points with the reference series. The acyclic series of the trade mark indicator have a conformity ratio of the classified series below 0.6, but a higher conformity ratio in the reference series. This explains why these series are acyclic but comply with the two-thirds criterion. In other words, the acyclic series all several turning points that are not paired with the trade mark indicator, or are false turning points.

([23]) NACE 1020 ‘Processing and preserving of fish, crustaceans and molluscs’ and NACE 2751 ‘Manufacture of electric domestic appliances’.

The turning points of the leading diffusion indices coincide, and their lead periods are 4.5 months ahead of the unweighted Leading Diffusion Index and 5 months ahead of the Weighted Leading Diffusion Index. As expected, the difference with the turning points of the diffusion indices using all series is minimal with only 1 month of difference in some lead periods and with no clear advantage in many of the indices.

Figure 4 Trade mark indicator and diffusion indices (SAR)

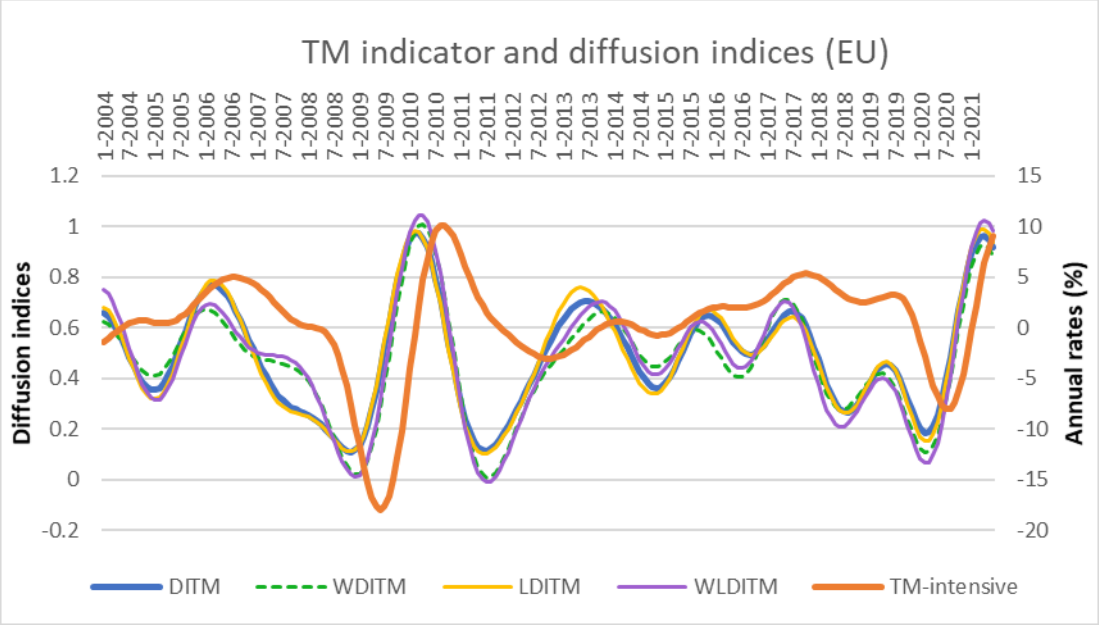
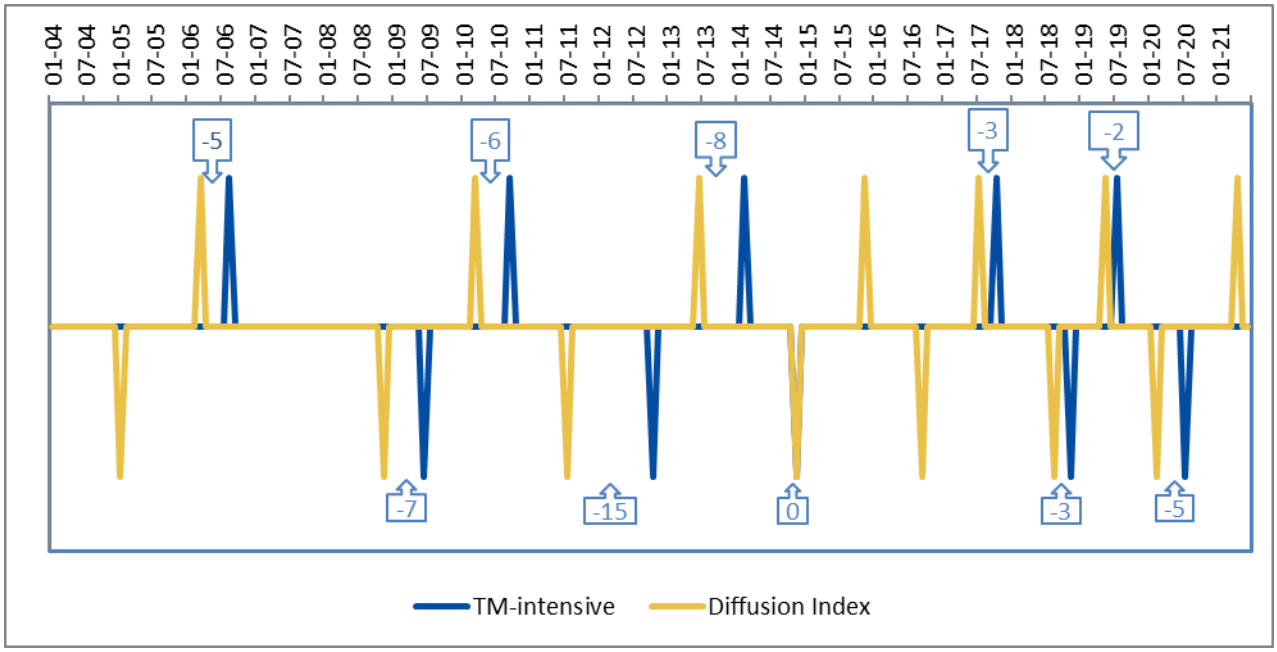


Figure 5 Trade mark indicator and Diffusion Index turning points and lead periods (months)



The four diffusion indices proposed for the trade mark indicator are very similar as is shown in Figure 4. In the February 2020 trough, 11 % of the series were trending upward and they represent 8 % of the VA of all trade mark intensive industries but only 1 % of the leading series. Finally, and as was the case for the IPR indicator, the 2009 recession was more pronounced and widespread for trade mark intensive industries than the 2020 trough.

3.3 Design diffusion indices

A total of 104 STS series are available for the construction of diffusion indices for the design indicator, of which only 3 are leading series, 9 are lagging and none are classified as acyclic series. The series with the highest weight is NACE class 2910 ([24]), which is 10.5 % of the total.

([24]) NACE 2910 'Manufacture of motor vehicles', this series is coincident with a median delay of 1 month with respect to the design indicator and 13 out of 14 of the paired turning points.

The design indicator has flagged the same cycles as with the IPR indicator, all of them paired with the diffusion indices which also have two extra turning points. This results in the same conformity ratios of 1 and 0.86. The median lead time is 4 months of advance for both diffusion indices.

Compared with the IPR and trade mark indicators, the design-intensive industries started the last recovery phase 1 month before (June 2020) and the diffusion indices flagged this turning point in March, with only 3 months of advance, confirming the lower lead period of diffusion indices for designs.

Table 5 Turning points dates of design indicator and diffusion indices

DES indicator		DES Diffusion index		DES Weighted Diffusion index	
Peak	Trough	Peak	Trough	Peak	Trough
06-2004	03-2005	12-2003 (-6)	12-2004 (-3)	12-2003 (6)	01-2005 (-2)
07-2006	06-2009	03-2006 (-4)	11-2008 (-7)	03-2006 (-4)	11-2008 (-7)
09-2010	08-2012	03-2010 (-6)	07-2011 (-13)	03-2010 (-6)	07-2011 (-13)
03-2014	12-2014	07-2013 (-8)	11-2014 (-1)	10-2013 (-5)	11-2014 (-1)
03-2016	09-2016	11-2015 (-4)	10-2016 (+1)	12-2015 (-3)	09-2016 (0)
11-2017	*	07-2017 (-4)	08-2018 (*)	07-2017 (-4)	08-2018 (*)
*	06-2020	05-2019 (*)	03-2020 (-3)	06-2019 (*)	03-2020 (-3)
		03-2021 (*)		05-2021 (*)	

Note: the difference between the date of the turning points of the diffusion indices and the IPR indicator is shown in parentheses. Negative values correspond to turning points anticipated by the diffusion index.

* no correspondence between IPR indicator and the diffusion indices

The leading diffusion indices include only acceptable series based on the two-thirds criterion. There are only 47 series in the leading indicator, or 45 % of the series included in the design indicator. This is sufficient to estimate leading diffusion indices although with less series than the corresponding IPR and trade mark leading diffusion indices. Only 8 series flagged all the turning points of the design indicator, compared with 18 series in the IPR and 49 in the trade mark leading diffusion indices.

Table 6 Turning points dates of design indicator and leading diffusion indices

DES indicator		DES Leading Diffusion index		DES Weighted Leading Diffusion index	
Peak	Trough	Peak	Trough	Peak	Trough
06-2004	03-2005	12-2003 (-6)	01-2005 (-2)	11-2003 (-7)	12-2004 (-3)
07-2006	06-2009	04-2006 (-3)	11-2008 (-7)	02-2006 (-5)	09-2008 (-9)
09-2010	08-2012	03-2010 (-6)	07-2011 (-13)	02-2010 (-7)	06-2011 (-14)
03-2014	12-2014	07-2013 (-8)	11-2014 (-1)	06-2013 (-9)	08-2014 (-4)
03-2016	09-2016	11-2015 (-4)	08-2016 (-1)	08-2015 (-7)	07-2016 (-2)
11-2017	*	07-2017 (-4)	09-2018 (*)	07-2017 (-4)	08-2018 (*)
*	06-2020	05-2019 (*)	02-2020 (-4)	07-2019 (*)	03-2020 (-3)
		03-2021 (*)		05-2021 (*)	

Note: the difference between the date of the turning points of the diffusion indices and the IPR indicator is shown in parentheses. Negative values correspond to turning points anticipated by the diffusion index.

* no correspondence between IPR indicator and the diffusion indices

The leading diffusion indices flagged the same turning points as were estimated by the diffusion indices based on all the series and with all the turning points anticipated. The median lead period of the leading diffusion indices are 5 and 6 months of advance for unweighted and weighted diffusion indices. This means that the Weighted Leading Diffusion Index shows the best results, with some turning points anticipated ing until four months the ones flagged by the indices with all the series.

Even though there are few series in the leading diffusion indices, they are better as leading indicators.

In the 2020 recession, the trough is reached in February with only 7 % of the series trending upward and representing the same share of the VA of design-intensive industries. When only the acceptable series are included, they represent 4 % of the total series. The results of the diffusion indices was even worse in the 2009 recession, as occurred with the IPR and trade mark indices.

Figure 6 Design indicator and diffusion indices (SAR)

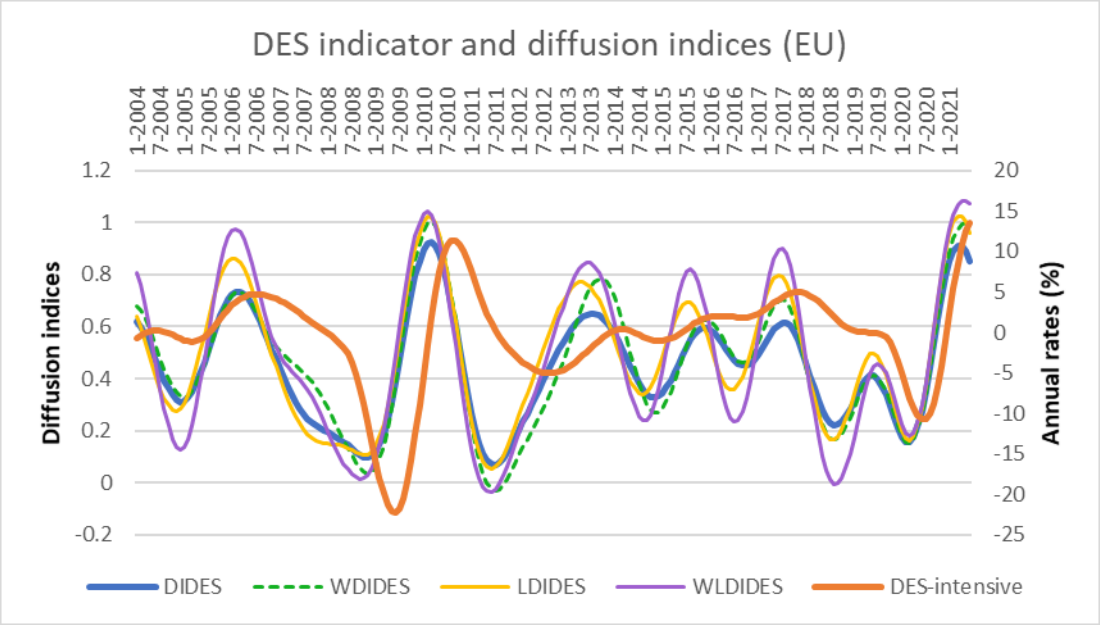
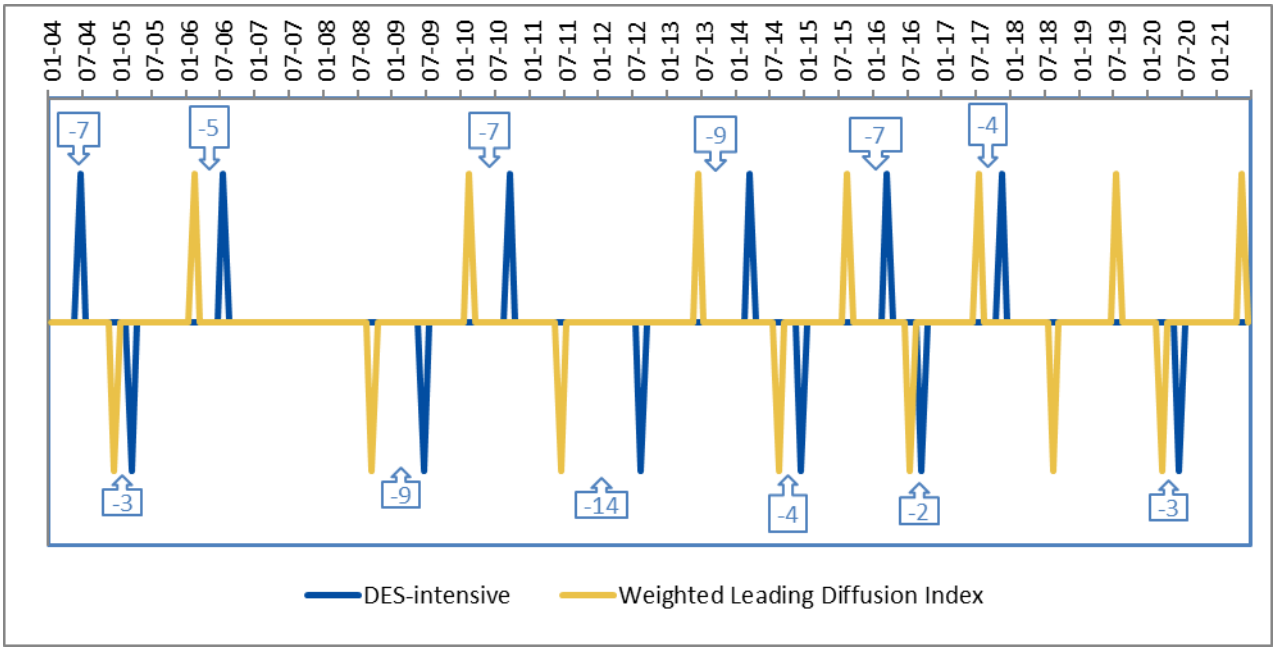


Figure 7 Design indicator and Weighted Leading Diffusion Index turning points and lead periods (months)

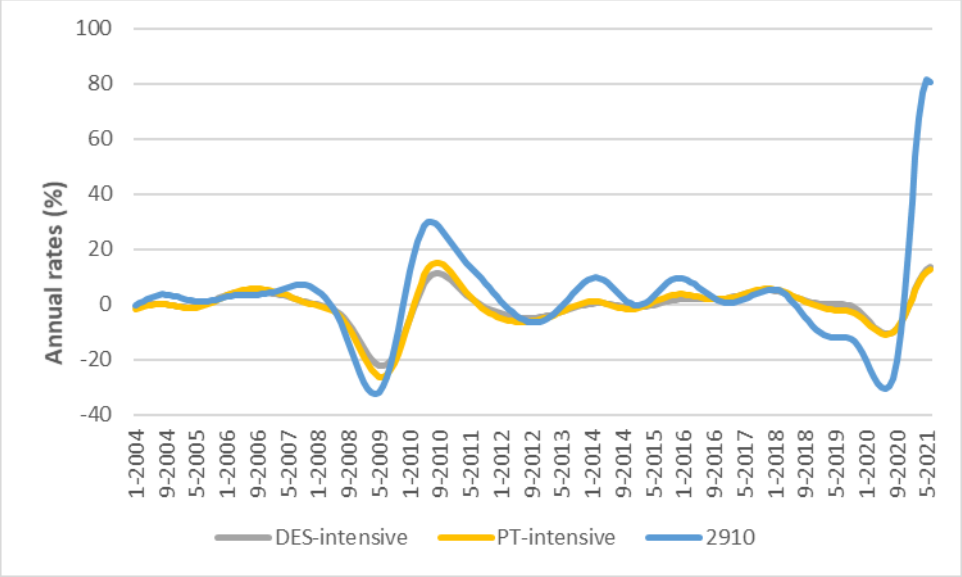


3.4 Patent diffusion indices

The patent indicator for the EU includes a total of 88 STS series, with only 3 series in the service sector and including 5 leading series, 6 lagging series and no acyclic series. The patent indicator only includes series from the manufacturing and service sectors with the highest weight of 13 % in the NACE class 2910 ([25]).

Figure 8 compares the design and patent indicators' SAR with the NACE class 2910 series. This series has a cyclical shape very similar to both indicators with 13 out of 14 turning points paired and classified as coincident with both indicators. NACE class 2910 registers annual rates of more than 80 % in May and June 2021, explained by a value of 9 in the base 2015 index ([26]) one year before. After 9 months with annual rates between -20 % and -30 %, this series is still 30 % below its pre-crisis level and in May reached a peak that is a sign of the end of the increasing annual rates.

Figure 8 Design and patent indicators and NACE class 2910 (SAR)



([25]) NACE 2910 'Manufacture of motor vehicles', this series is coincident with a median delay of 1 month with respect to the patent indicator and 13 out of 14 paired turning points.

([26]) The base 2015 index means that in that year the average value of the index was 100 so that in April 2020 the production value was 9 % of the average production in 2015.

The patent indicator flagged the same turning points as the IPR and design indicators, and all of them are paired with the diffusion indices which have 2 additional unpaired turning points. This results again in conformity ratios of 1 and 0.86.

As with the design indicator, the patent indicator flagged the last trough in June 2020, 1 month before than the IPR and trade mark indicators. The last peaks of both diffusion indices are dated in March and May 2021.

The median lead periods of the diffusion indices are -4.5 and -4 months for the unweighted and weighted diffusion indices respectively.

Table 7 Turning points dates of patent indicator and diffusion indices

PT indicator		PT Diffusion index		PT Weighted Diffusion index	
Peak	Trough	Peak	Trough	Peak	Trough
07-2004	03-2005	12-2003 (-7)	01-2005 (-2)	12-2003 (-7)	12-2004 (-3)
09-2006	06-2009	04-2006 (-5)	11-2008 (-7)	02-2006 (-7)	10-2008 (-8)
08-2010	06-2012	03-2010 (-5)	07-2011 (-11)	03-2010 (-5)	07-2011 (-11)
01-2014	11-2014	07-2013 (-6)	11-2014 (0)	08-2013 (-5)	10-2014 (-1)
12-2015	10-2016	11-2015 (-1)	08-2016 (-2)	10-2015 (-2)	09-2016 (-1)
11-2017	*	07-2017 (-4)	09-2018 (*)	08-2017 (-3)	09-2018 (*)
*	06-2020	05-2019 (*)	02-2020 (-4)	07-2019 (*)	03-2020 (-3)
		03-2021 (*)		05-2021 (*)	

Note: the difference between the date of the turning points of the diffusion indices and the IPR indicator is shown in parentheses. Negative values correspond to turning points anticipated by the diffusion index.

* no correspondence between IPR indicator and the diffusion indices

There are 44 acceptable series following the two-thirds criterion, exactly half of the series included in the patent indicator and only 9 of them have flagged all the turning points of the reference indicator. None of the service sector series is acceptable and only three out of five leading series are selected for the leading diffusion indices.

The same turning points are flagged by the leading diffusion indices which have median lead periods of 6 and 5 months of advance.

Table 8 Turning points dates of patent indicator and leading diffusion indices

PT indicator		PT Leading Diffusion index		PT Weighted Leading Diffusion index	
Peak	Trough	Peak	Trough	Peak	Trough
07-2004	03-2005	10-2003 (-9)	12-2004 (-3)	11-2003 (-8)	12-2004 (-3)
09-2006	06-2009	02-2006 (-7)	10-2008 (-8)	02-2006 (-7)	09-2008 (-9)
08-2010	06-2012	02-2010 (-6)	06-2011 (-12)	02-2010 (-6)	06-2011 (-12)
01-2014	11-2014	03-2013 (-10)	08-2014 (-3)	06-2013 (-7)	08-2014 (-3)
12-2015	10-2016	07-2015 (-5)	05-2016 (-5)	08-2015 (-2)	07-2016 (-3)
11-2017	*	05-2017 (-6)	07-2018 (*)	07-2017 (-4)	07-2018 (*)
*	06-2020	05-2019 (*)	02-2020 (-4)	07-2019 (*)	03-2020 (-3)
		03-2021 (*)		04-2021 (*)	

Note: the difference between the date of the turning points of the diffusion indices and the IPR indicator is shown in parentheses. Negative values correspond to turning points anticipated by the diffusion index.

* no correspondence between IPR indicator and the diffusion indices

Figure 9 Patent indicator and diffusion indices (SAR)

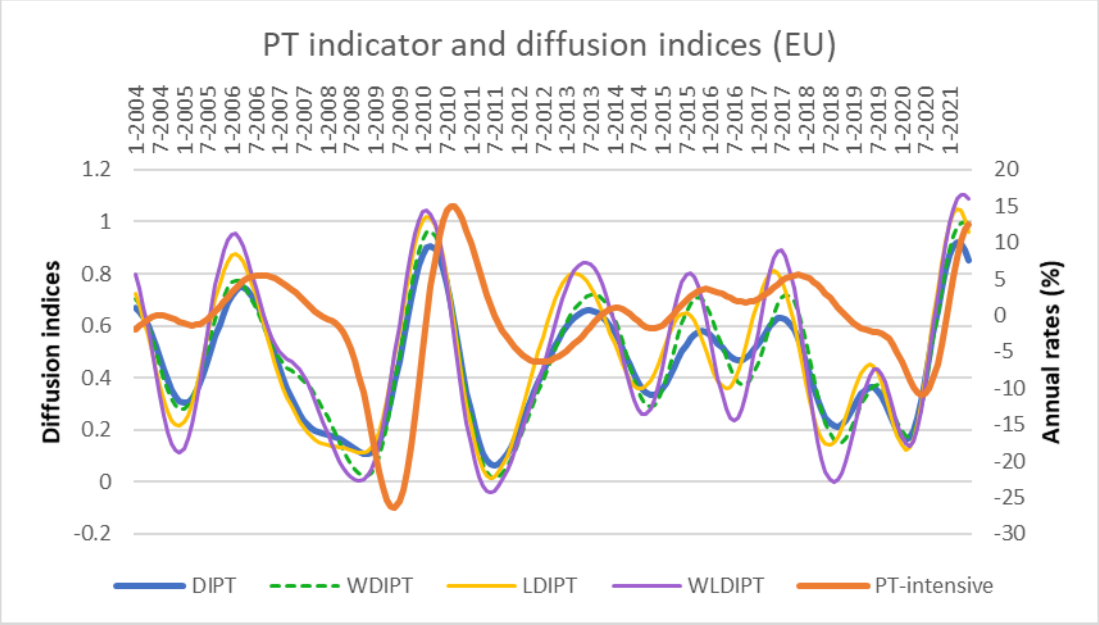
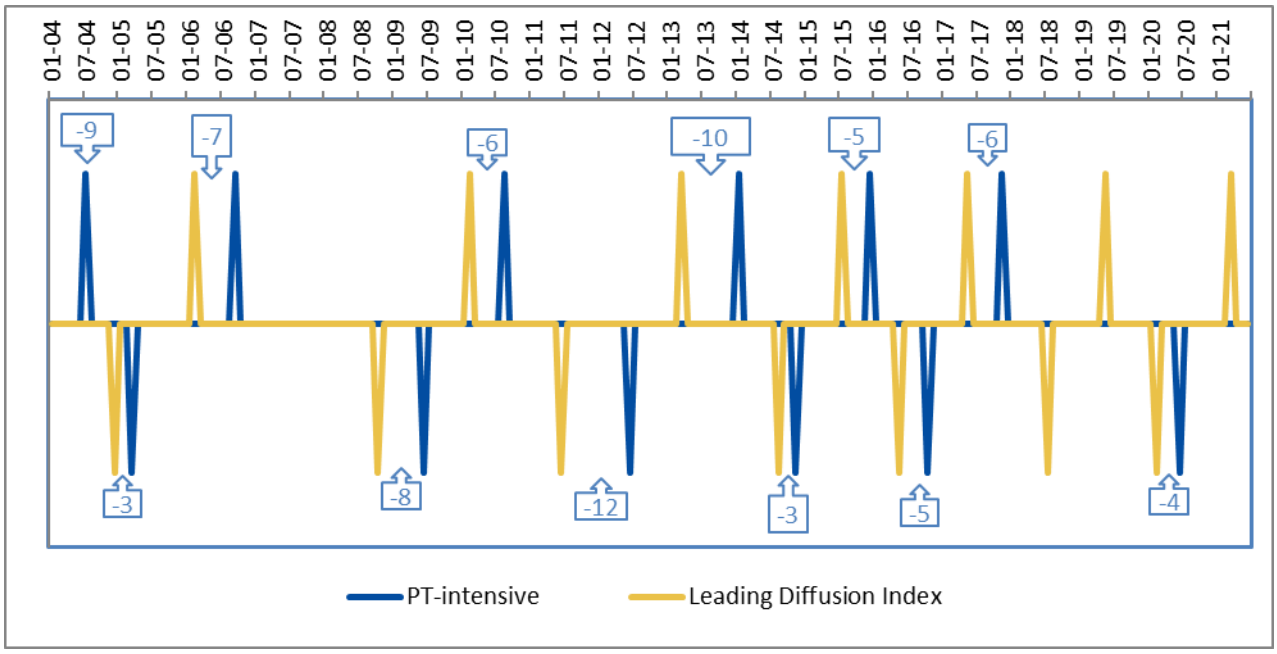


Figure 10 Patent indicator and Leading Diffusion Index turning points and lead periods (months)



The patent indicator is very similar to the design one and the leading diffusion indices are also clearly better than the diffusion indices using all the series. The values of the diffusion indices also show that the 2009 recession phase was more widespread than the 2020 crisis.

4 Diffusion indices for the Member States

Based on the available STS series some of the IPR indicators can be estimated for the four largest EU MS: France and Spain can have all four indicators estimated; Germany can have the design and patent indicators estimated; and the patent indicator can be estimated for Italy. All the MS indicators have been estimated based on more series than the corresponding EU indicators and with different weights, as explained in more detail in EUIPO (2021a).

The appendix shows the classification of the component series in leading, coincident, lagging or acyclic for all indicators at MS level.

The four diffusion indices discussed in Section 3 have been estimated for each of the IPR indicators and the results are summarised in this section grouped by IPR.

4.1 IPR diffusion indices for the Member States

Complete data for the estimation of the IPR indicator is only available for France and Spain, with a total of 177 and 173 STS series respectively. The four diffusion indices discussed for the EU are also estimated for these two countries with 102 series considered acceptable following Moore's two-thirds criterion for the French leading diffusion indices and 73 series for the Spanish leading diffusion indices, a lower percentage of acceptable series than for the EU indices.

The weights applied for the three main sectors (manufacturing, wholesale and service) are different for each country ([27]), with the French IPR indicator weighting less than the EU manufacturing sector, but more than the service sector. Nevertheless, the component series with the higher weight in the Weighted Diffusion Index for all IPR in France and Spain is the same as in the EU indices, NACE division 62, with a higher weight in France (8.7 %) and a similar weight in Spain (7.1 %).

Figure 11 shows the IPR indicators and the set of four diffusion indices for the two countries. The IPR indicators for France and Spain flagged 15 turning points in the first two decades of the 21st century but there are some differences between the cyclical characteristics of both indicators.

The amplitude of the recession and recovery phases is the difference between the annual rates in two consecutive turning points (peak and trough or vice versa). The first difference is that the median amplitude of both phases is about 9 percentage points (p.p.) in Spain and 3 p.p. in France and it is very asymmetric in the EU with a median of 4 p.p. in the recovery phases and 1 p.p. in the recessions.

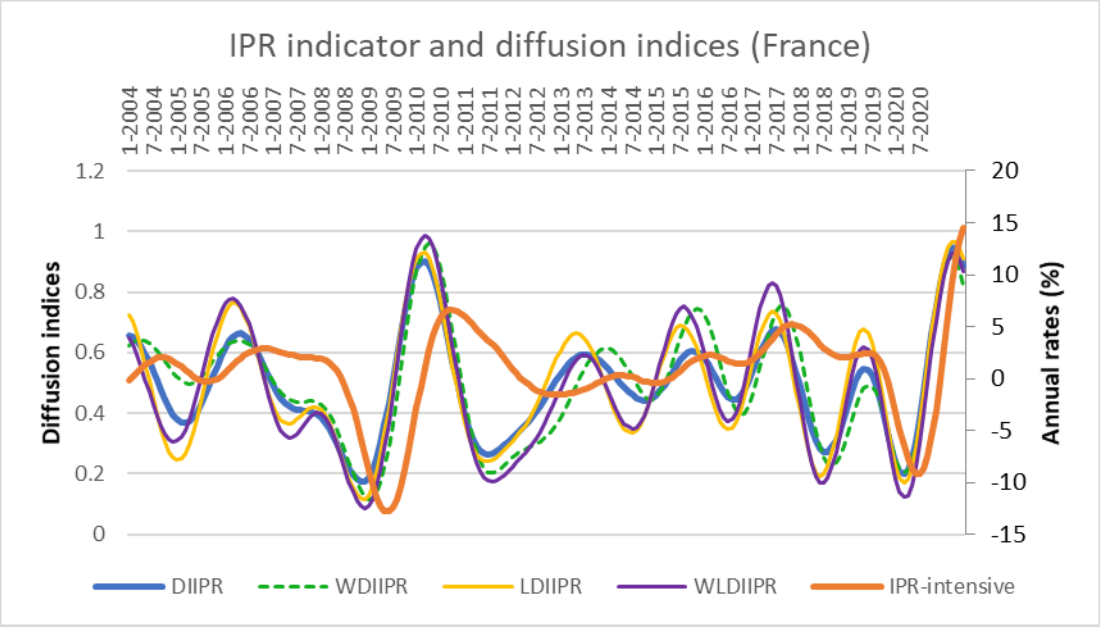
Additionally, the median duration of the recovery phases is similar in both countries, but the median duration of the recession phases is longer in France. As a result, in Spain the number of months in

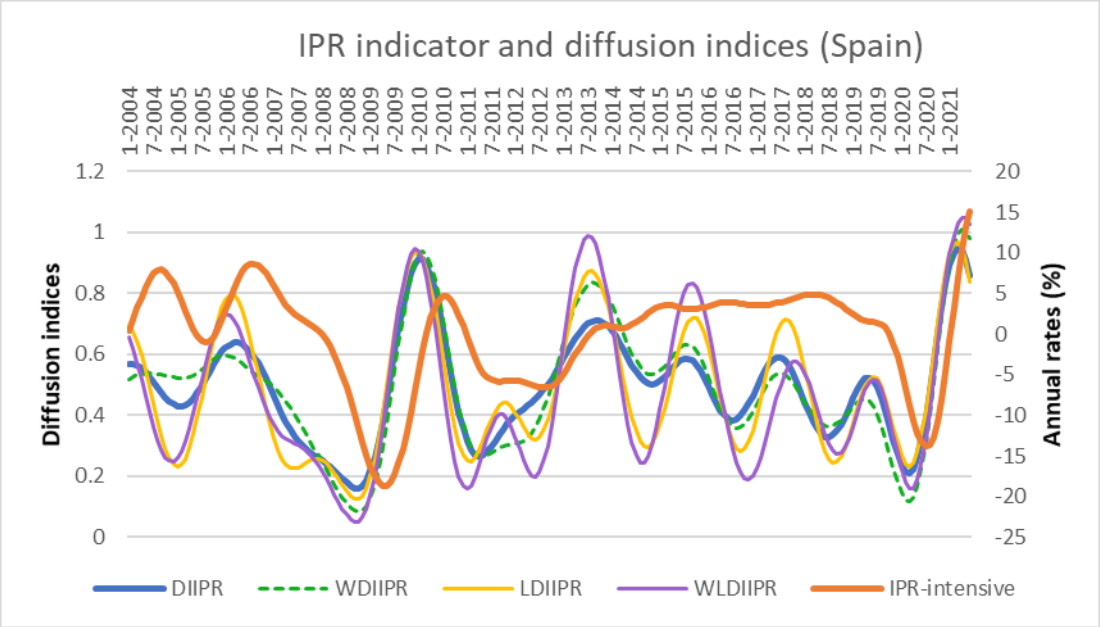
([27]) Table 14 in the appendix shows the different weights for all indicators and MS.

recession is practically the same as the number of months in the recovery. However, in France the total time in recession exceeded the total time of the recovery phases by 18 months.

Finally, the average annual rate in Spain since 2003 is negative (-0.24 %) while in France and the EU it is positive (0.49 % and 0.14 % respectively), with a double standard deviation of the cyclical signal in Spain confirming the higher volatility of the Spanish indicator. In 2009, the minimum annual rates for this period were reached in both countries, as well as in the EU, with a value of -12.8 % in France (June 2009), -18.5 % in Spain (April 2009) and an even higher slump in the EU (-18.9 % in June 2009).The maximum rate was reached in France and Spain in the last month of the series (June 2021), with values about +15 % in both countries, but in the EU that maximum rate was reached in September 2010 with a rate slightly below 10 %.

Figure 11 IPR indicators and diffusion indices for France and Spain (SAR)





Diffusion indices will now be compared based on the dates of their turning points. The two French leading diffusion indices have flagged two extra (false) turning points (not considering the last peak in 2021) resulting in conformity ratios of 0.93 and 0.81 The Weighted Diffusion Index and the Diffusion Index both flagged 14 turning points resulting in conformity ratios of 1 and 0.93.

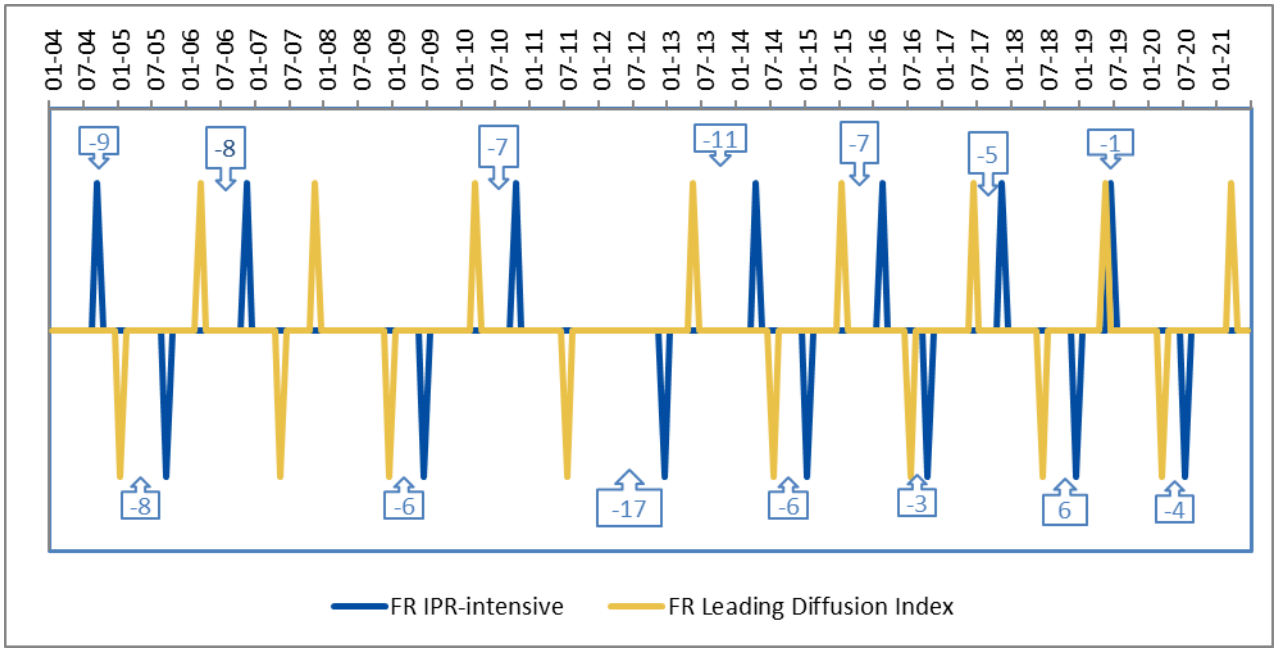
All the diffusion indices flagged a peak in 2021 and this should be interpreted as the prediction of the end of the current expansionary phase for the IPR-intensive industries for later 2021. The Weighted Diffusion Index flagged the last peak in April 2021 and the rest of the diffusion indices did so in March.

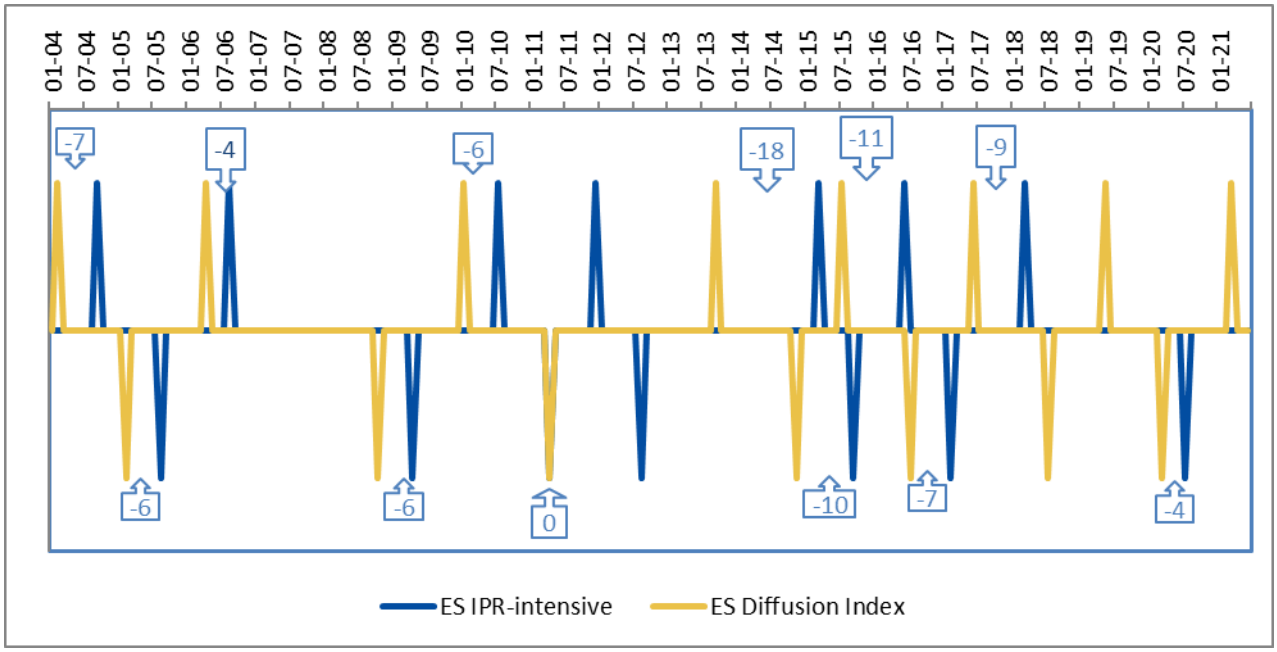
The Leading Diffusion Index is the one that anticipates the most the turning points of the IPR indicator, with a median lead time of 6 months of advance.

The Spanish Leading Diffusion Index flagged two extra (false) turning points in 2007 and all the diffusion indices also flagged one cycle between 2018 and 2019 that was not reflected in either the IPR indicator of the EU indicator. Additionally, there was a small cycle of the IPR indicator in 2012 that was only anticipated by the two leading diffusion indices. This results in the following conformity ratios: 0.93 and 0.74 for the Leading Diffusion Index; 0.93 and 0.88 for the weighted leading diffusion indices; and 0.8 and 0.86 for the two indices estimated with all the series.

With regards to the median lead periods, the Weighted Leading Diffusion Index would be the preferred index if we consider the complete time series. However, the Diffusion Index based on all the component series is the one that best anticipated the turning points in the last five years (although it did not detect a short cycle between 2011 and 2012 that was only flagged by the two leading diffusion indices). To conclude, the Diffusion Index, with a median lead period of -6 months is the preferred indicator based on the timing of the turning points. All the diffusion indices have flagged the end of the current expansionary phase, with the unweighted diffusion indices dating the peak in March 2021 and the weighted diffusion indices dating it in April 2021, and this anticipates a slowdown in IPR-intensive industries at the end of 2021.

Figure 12 IPR indicators and best diffusion indices turning points and lead periods (months) for France and Spain





The diffusion indices are leading economic indicators that anticipate changes from recessions to recovery phases (and vice versa). They also measure the dispersion of the IPR indicator's recession (recovery), such as the number of series trending upward. This makes it possible to distinguish between recession (or recovery) phases limited to a few industries from widespread recession (or recovery) phases. Based on the French and Spanish IPR diffusion indices, the last recovery phase marked the highest value since 2001 with 95 % of the series trending upward in the first months of 2021, while for the EU the maximum value of diffusion indices was reached in 2010. The value of the diffusion indices in the 2009 and 2020 troughs are very similar, with less than 10 % of the series trending upward. Therefore, the 2009 financial crisis resulted in lower rates of the IPR indicator than in the 2020 crisis, while the rates were equally spread among the French and Spanish IPR-intensive industries in both crisis.

4.2 Trade mark diffusion indices for the Member States

The trade mark indicators have been estimated for France and Spain with 141 and 139 STS series respectively, of which 83 and 62 are included in the leading diffusion indices based on the two-thirds criterion, which is a lower percentage of acceptable series than in the EU indices.

The French trade mark indicator has been estimated with a higher weight in the wholesale sector and a lower weight in the manufacturing sector compared with the EU indicator. The Spanish indicator is weighted more to the wholesale sector and less to the service sector. Consequently, the highest weights in the Weighted Diffusion Index are for the NACE 464 ([28]) (7.2 %) in the French indices and NACE 466 ([29]) (7.7 %) in the Spanish indices, while for the EU the 1920 NACE class has the highest weight.

In the same period, the French trade mark indicator flagged 13 turning points and the Spanish indicator flagged 15 turning points. The median amplitude is higher for the recessions than for the recovery phases and much higher in Spain than in France, with 12 p.p. for the Spanish recessions and 9 p.p. for recoveries while in France the amplitudes are about 6 p.p. and 4 p.p.

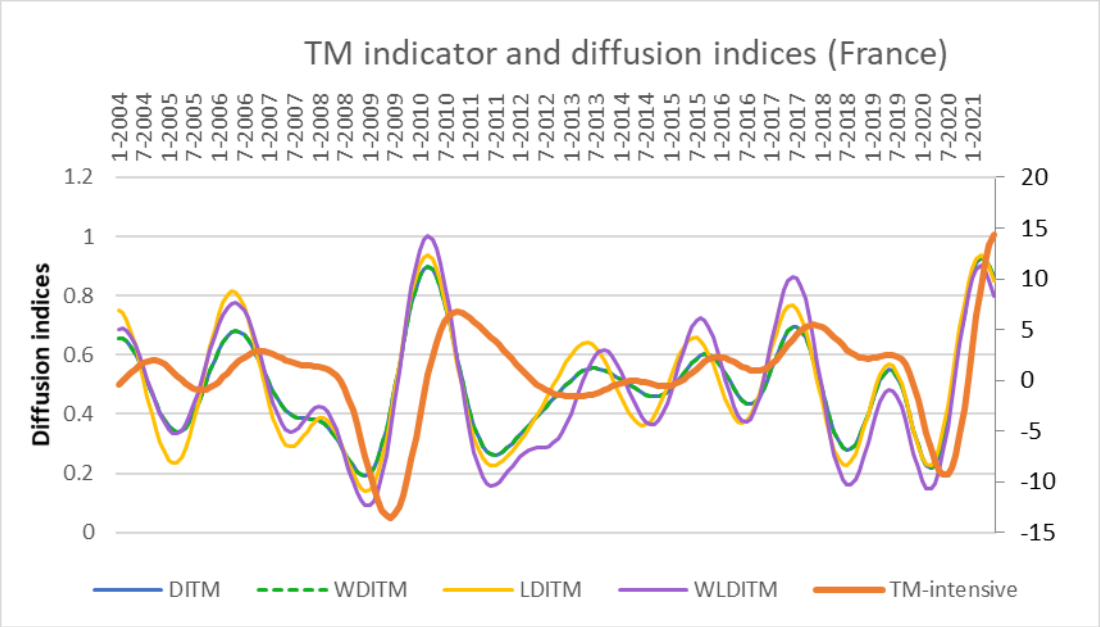
Similar to the IPR indicator, the median duration of the trade mark indicators' recovery phases are comparable (14 months in France and 13 months in Spain) but recessions in France have a longer median duration than in Spain with 20 months in France and 11 months in Spain. As a result, since 2001 there are more months in recession phases than in recovery phases in both countries but the difference is 30 months in France while in Spain it is only 5 months.

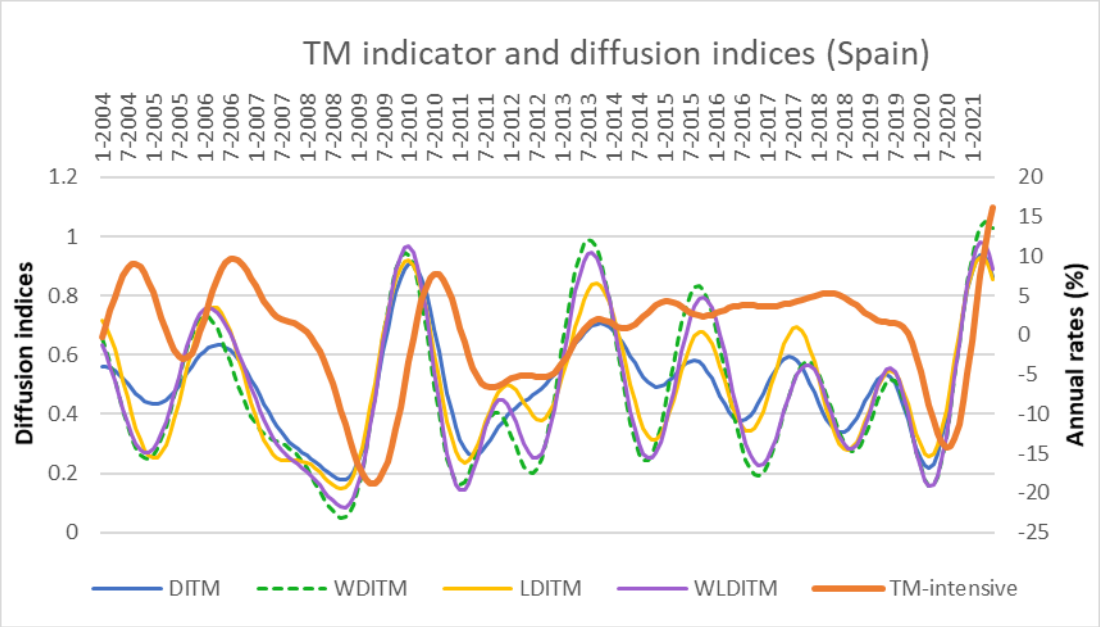
With respect to the annual rates of the trade mark indicators, their average is small but positive in the two countries and in the EU; between 0.01 % in Spain and 0.35 % in France. The maximum and minimum annual rates of the period are reached in the same months as the IPR indicators and the magnitude of the maximum rates are also similar, with the highest minimum rate in Spain occurring in the 2009 trough.

([28]) NACE 464 'Wholesale of household goods'.

([29]) NACE 466 'Wholesale of other machinery, equipment and supplies'.

Figure 13 Trade mark indicators and diffusion indices for France and Spain (SAR)





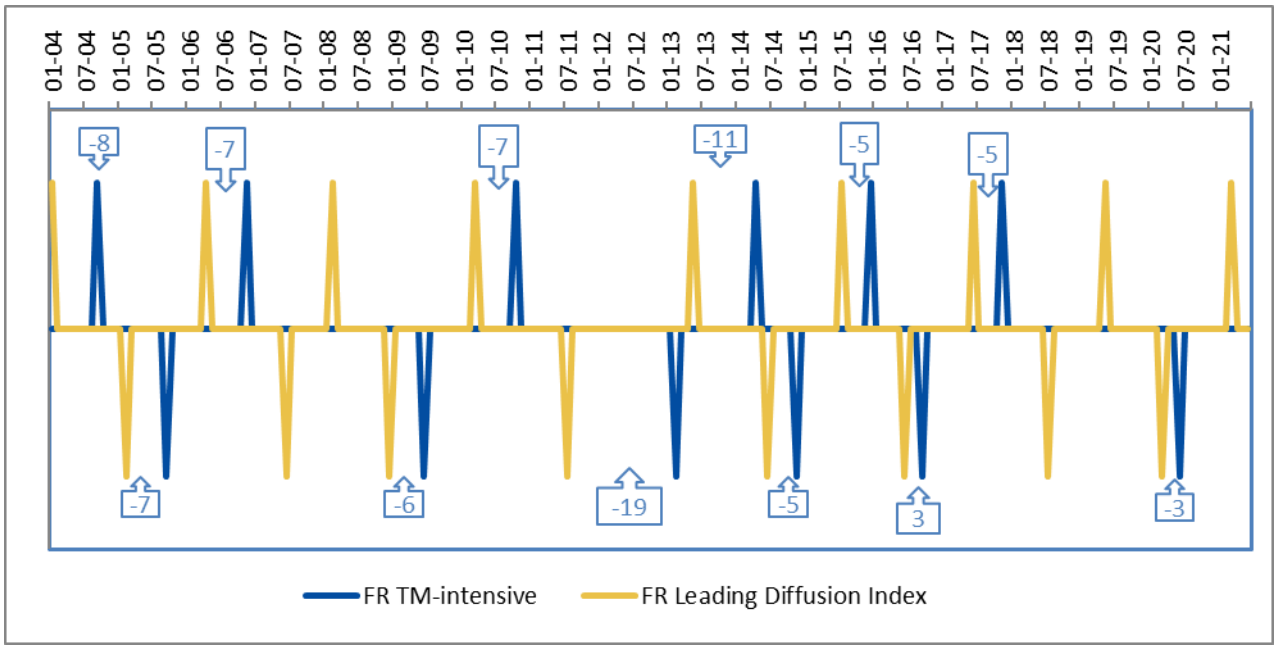
The French leading diffusion indices (weighted and unweighted) detected four extra (false) turning points resulting in conformity ratios of 0.92 and 0.71 for the Leading Diffusion Index and 0.92 and 0.75 for the Weighted Leading Diffusion Index. The conformity ratios for the diffusion indices based

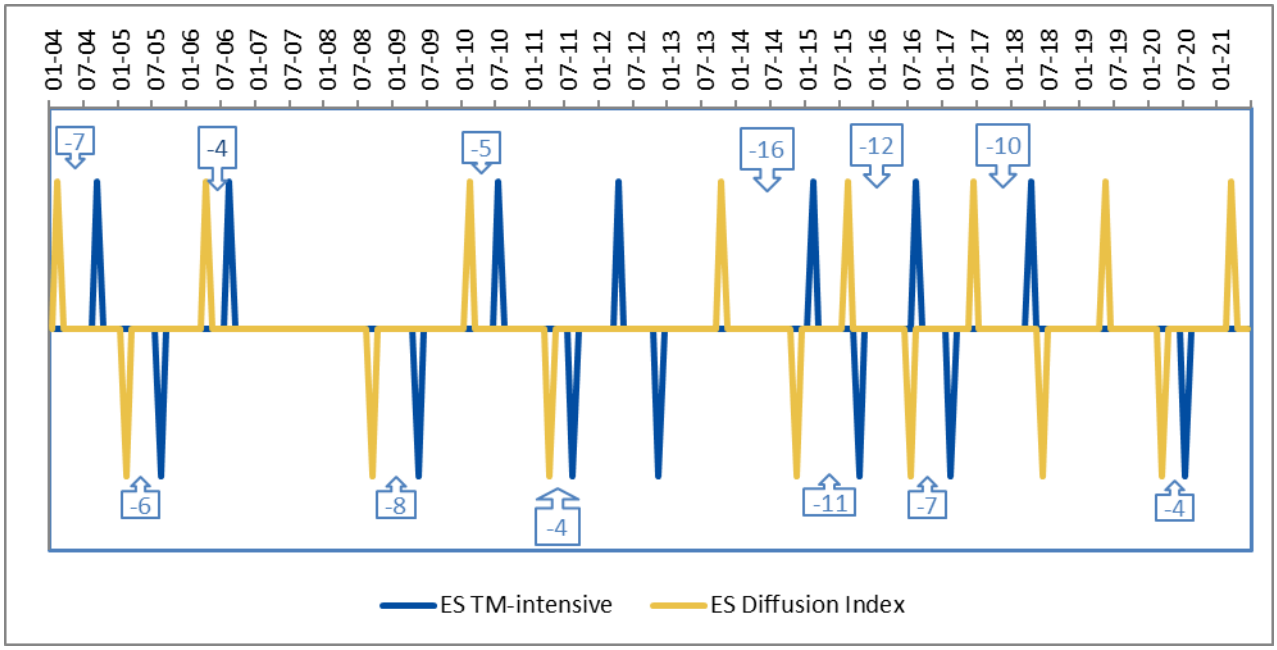
on all the available series are the same for the reference series (0.92) and higher for the classified series, 0.80 for the Diffusion Index and 0.86 for the Weighted Diffusion Index.

The Leading Diffusion Index anticipates the most the turning points of the trade mark indicator with a median lead time of -6.5 months. The last trough was flagged in February 2020 by the indices using the 83 acceptable series and in March 2020 by the indices using all the series. All the diffusion indices detected a peak in March 2021 as a sign of a future slowing down of the rhythm of growth of trade mark intensive industries for the end of the current year.

The Spanish diffusion indices are very similar for trade marks and all IPRs with differences of just 1 month in the dates of the turning points. The preferred index since 2015 would be the Diffusion Index which has a median lead period of 7 months. However, all the diffusion indices detected the end of the last acceleration phase, three of them in March 2021 and the Weighted Diffusion Index in April 2021.

Figure 14 Trade mark indicators and best diffusion indices turning points and lead periods (months) for France and Spain





The diffusion indices for the French and Spanish trade mark intensive industries show that the 2020 economic crisis and the subsequent recovery in 2021 are spread among 90 % of the industries, which also happened in the 2009 financial crisis.

4.3 Design diffusion indices for the Member States

Eurostat publishes 218 STS series of the German manufacturing and wholesale sectors. This permits the estimation of the design and patent indicators, as well as the corresponding diffusion indices. Therefore, design indicators and the corresponding diffusion indices have been estimated for Germany, France and Spain based on 139, 121 and 118 STS series respectively. For the leading diffusion indices the number of acceptable series based on the two-thirds criterion are 94 in Germany, 74 in Spain and 66 in France.

With regards to the weights used for the calculation of the weighted diffusion indices it must be kept in mind that STS for the service sector are not available for Germany, but also that this sector's weight is only 5 % in the design-intensive industries. The main characteristic of the German design indicator is a weight of 81 % for the manufacturing industries, compared with 71 % for the EU, 70 % for Spain and 64 % for France. The French wholesale sector's weight is 30 % which is 10 points

higher than in the EU indicator and more than double the weight in the German indicator. Consequently, the industries with the highest weightings are 2910 for the German indicator (14.3 %) with almost four points higher than in the EU indicator, 464 for the French indicator (13.5 %) and 467 ([30]) for the Spanish one (13.9 %).

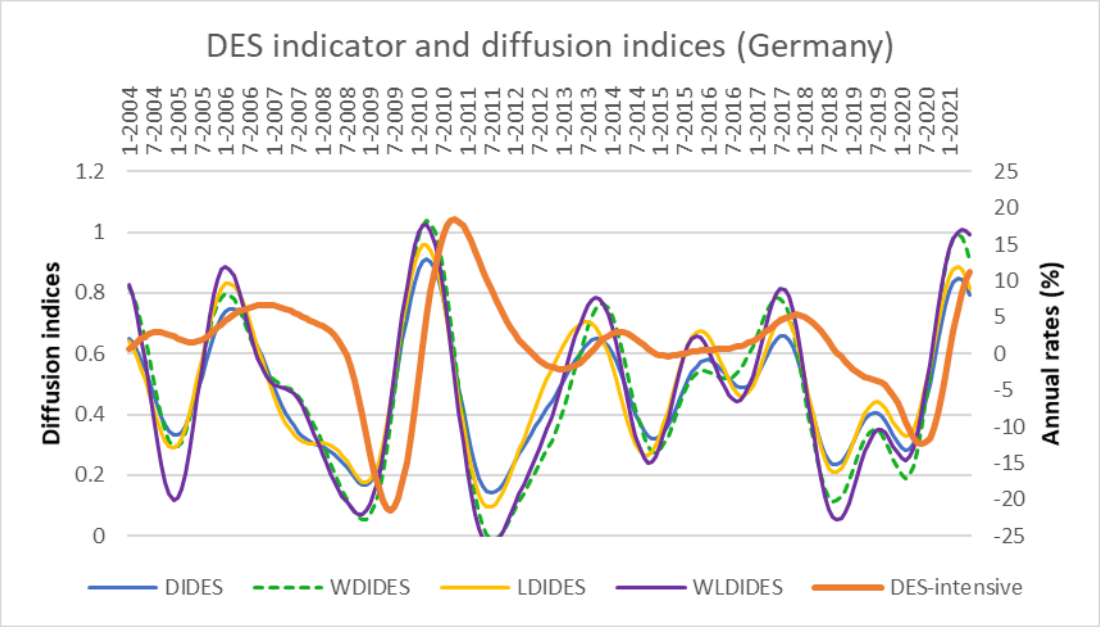
The cycles of the design indicators are quite different for each country. German has 10 turning points detected in the two decades analysed, Spain and the EU have 14, and France has 17. This results in big differences in the duration of the phases, especially in the recessions, with France and Spain having a median duration of 12 months, while in Germany it is 27 months.

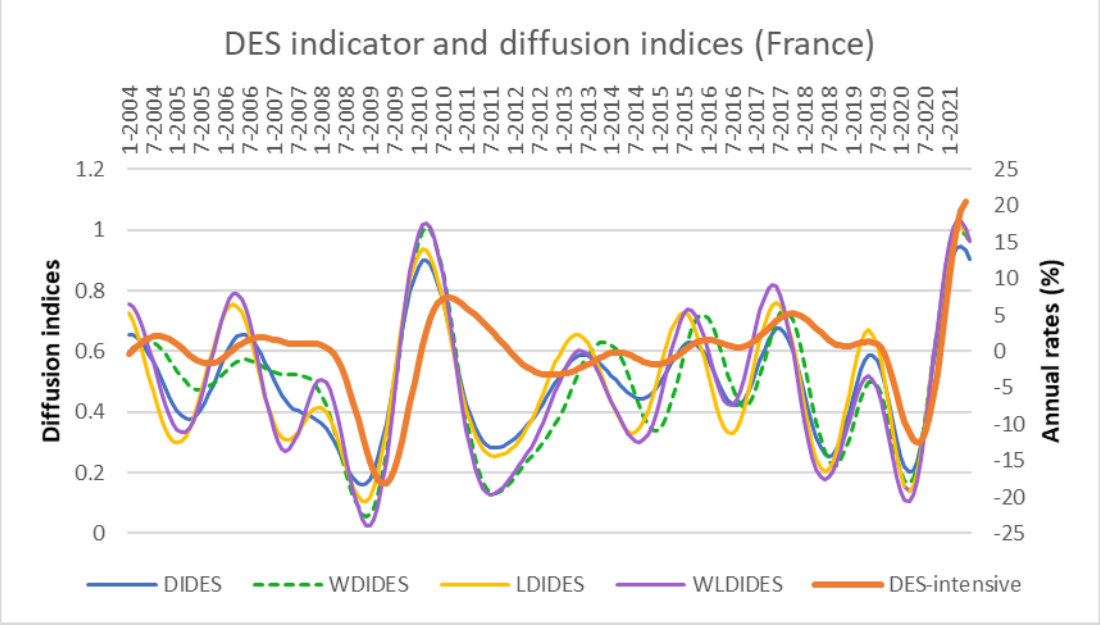
The German cycles are also very asymmetric in amplitude with 5 p.p. of median difference between turning points in the acceleration phases and 18 p.p. in the recession phases (even though the recovery phase starting in June 2009 had an amplitude of 40 p.p.). The median amplitude of the French and Spanish phases are about 4 p.p.

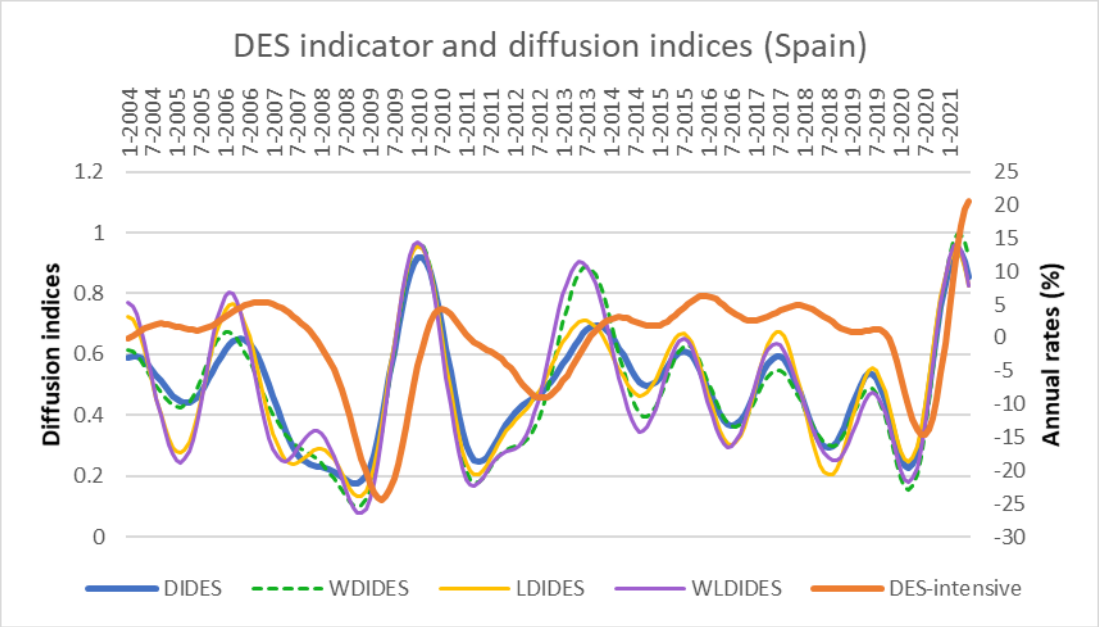
The average annual rate of the design indicator is positive for Germany (+0.89 %) and negative for France (-0.48 %), Spain (-0.71 %) and the EU (-0.61 %). As was the case with the IPR and trade mark indicators, in France and Spain the maximum annual rate with current data was reached in the last month of the period (June 2021) with a value of 20.6 % in both countries. In the EU the maximum was also reached in the last month of the series with a lower but still high annual rate of 13.6 %. In Germany the maximum was reached in October 2010 with a value of 18.4 %, 7 p.p. higher than the annual rate in June 2021. With regards to the minimum annual rates, the four design indicators flagged it in the 2009 trough with values between -18.2 % in France and -24.4 % in Spain.

([30]) NACE 467 ‘Other specialised wholesale’.

Figure 15 Design indicators and diffusion indices in Germany, France and Spain (SAR)







The German diffusion indices detected the same turning points, including four extra (false) turning points, resulting in conformity ratios of 1 and 0.71 ([31]). The comparison of the dates of the turning points shows that the Diffusion Index is the one that least anticipates phase changes, but it should also be mentioned that there are not significant differences among the other three indices. When the analysis is focused on the last cycles, the Weighted Diffusion Index is the preferred one with a median lead period of 6 months of advance and the last peak is in March 2021 in all the diffusion indices, except the Weighted Leading Diffusion Index which flagged it in April 2021.

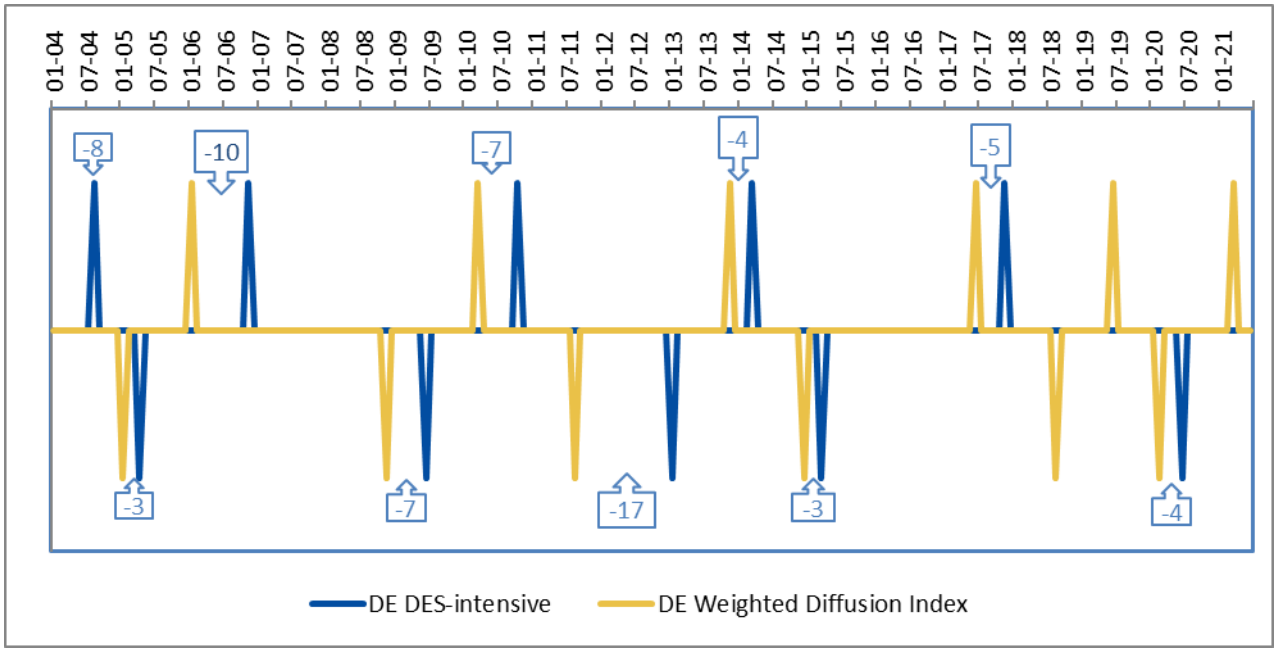
The French leading diffusion indices have flagged all the turning points of the design indicator resulting in conformity ratios of 0.94 and 1. The diffusion indices with all the series did not detect two turning points of the design indicator in 2008 and 2009 and their conformity ratios are 0.82 and 1. The preferred index to anticipate changes in the cycles is the Weighted Leading Diffusion Index with a median lead period of -6 months. Furthermore, it is the index that first flags the last trough, in February 2020, and also flags the last peak 1 month before the other diffusion indices, in March 2021.

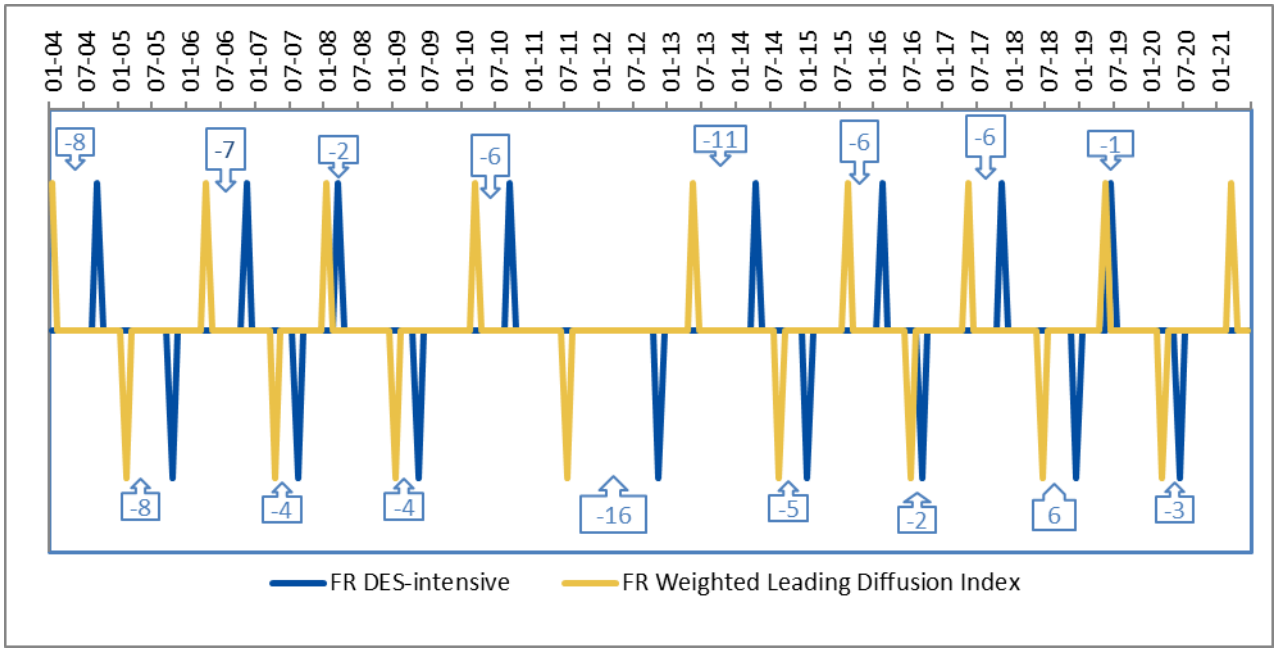
([31]) The low conformity ratio for classified series is explained by the small number of turning points detected in the German design indicator, which is more stable than the component series and this is also reflected in the high number of acyclic series (see Table 13 in the appendix).

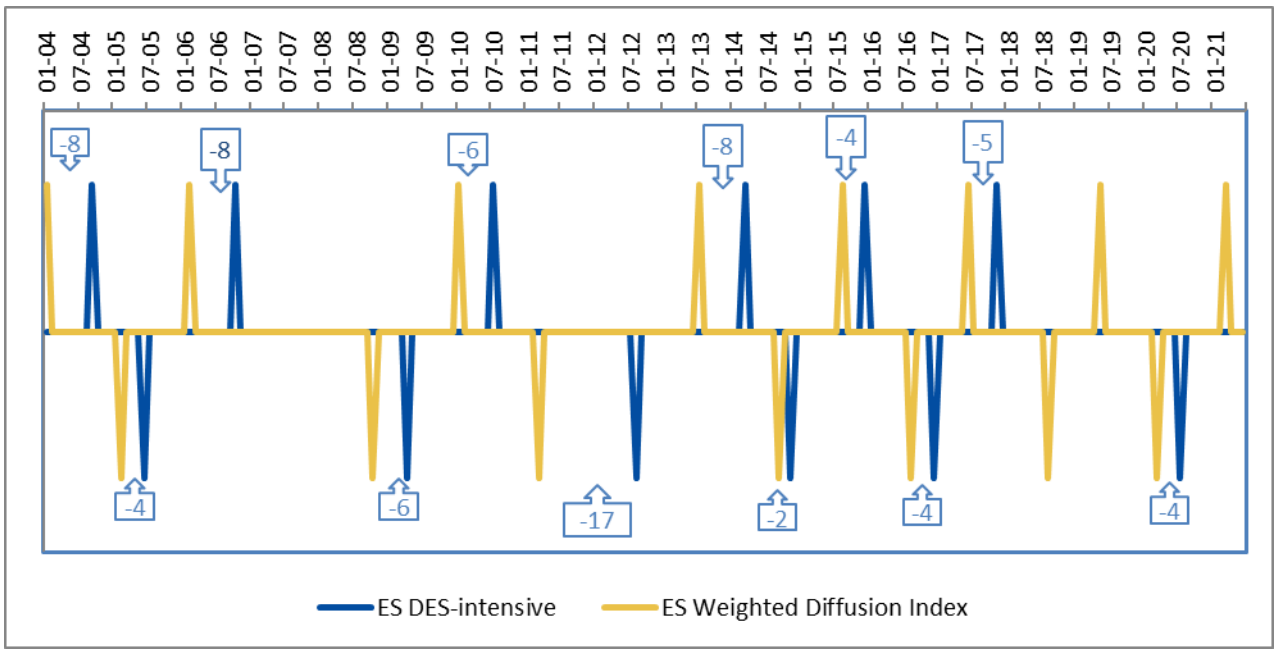
The two Spanish leading diffusion indices flagged two extra (false) turning points in 2007 and all the indices flagged another two extra (false) turning points between 2018 and 2019. The conformity ratios are 0.86 and 0.75 for the leading diffusion indices and 0.86 for both series and the diffusion indices with all the available design-intensive industries.

The Diffusion Index is the index with the worse performance with regards to the median lead periods. The Weighted Diffusion Index is then the preferred one with a median lead period of -5.5 months and the last trough flagged in March 2020. The last peak was flagged in March 2021 as a sign of the end of the current expansionary phase.

Figure 16 Design indicators and best diffusion indices turning points and lead periods (months) for Germany, France and Spain







Finally, the French and Spanish diffusion indices show that the 2009 and 2020 economic crises are equally spread among the design-intensive industries, while in Germany the number of industries trending downward was higher in 2009 than in the last trough in 2020.

4.4 Patent diffusion indices for the Member States

Eurostat publishes 150 STS series for Italy in the manufacturing sector, which permits the estimation of the patent indicator. Therefore, the patent indicators and diffusion indices have been estimated for the four largest EU MS and are presented in Figure 17. The total available series for the patent diffusion indices are 122 for the German indices, 108 for France, 92 for Italy and 98 for Spain. The leading diffusion indices use only the acceptable series based on the two-thirds criterion: 82 series for the German indices, 65 for France and Spain, and 54 series for the Italian leading diffusion indices. The Italian and German indicators do not include data for the service sector which represent only 6 % and 3 % respectively of the total VA of these industries. However, the French and Spanish indicators do include data from the service sector with weights of 8 % and 5 % respectively.

The industry with the highest weight in the calculation of the weighted diffusion indices for the EU, Germany, France and Spain is the NACE class 2910 with 9.5 % in France and Spain and 14.8 % in the German index. The industry with the highest weight in the Italian Weighted Diffusion Index is the NACE class 2120 ([32]) with a weight of 6.3 %.

The patent indicators have a cyclical behaviour similar to the design indicators and different in the four MS. The total number of turning points detected since 2001 ranges from 17 in France to 12 in Germany. The median amplitude and duration of the recessions in the two countries with the least number of cycles (Germany and Spain) are higher than the median amplitude and duration of the other MS and also higher than the median values of the recovery phases. The French indicator has symmetric cycles with the same median duration and amplitude of the recession and recovery phases. In Italy and the EU, the median amplitude of the recovery phases is almost double the median amplitude of the recessions and the acceleration phases last longer compared with the median length of recession phase.

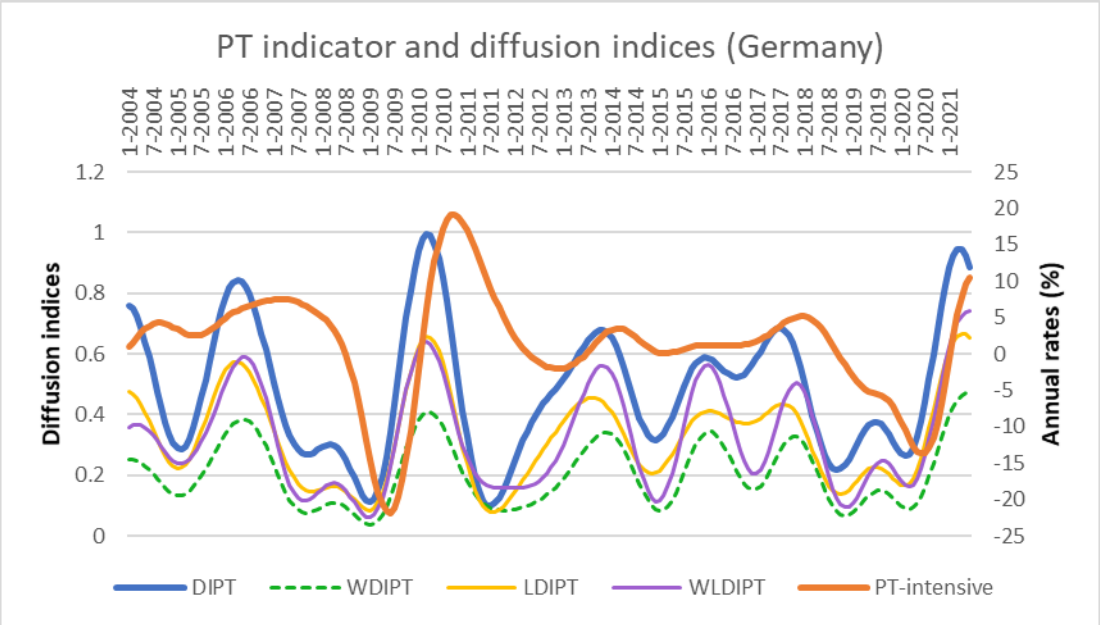
During the period analysed, the patent indicators are in recession longer than they are in recovery phases in the four largest MS. In Italy and Spain there are more than 30 months of difference between the total duration of recession and recovery phases.

([32]) NACE 2120 ‘Manufacturing of pharmaceutical preparations’.

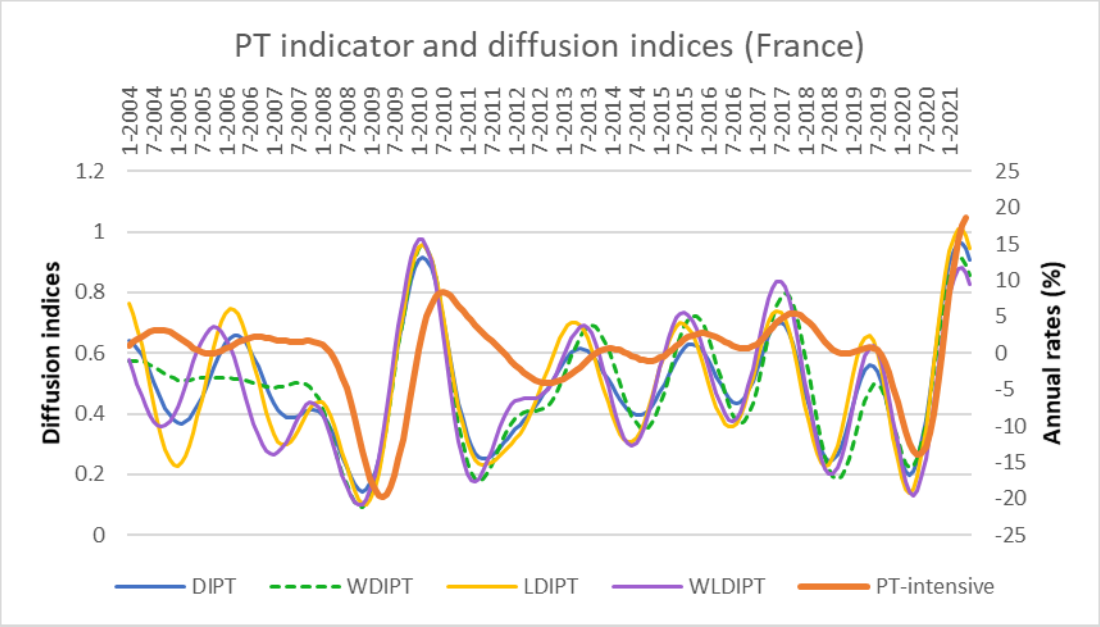
The average annual rates in the period are negative except for Germany with an average of 1 p.p. The Italian indicator and the EU average registered an average rate of almost -1 p.p. while France and Spain have average rates of about -0.5 p.p.

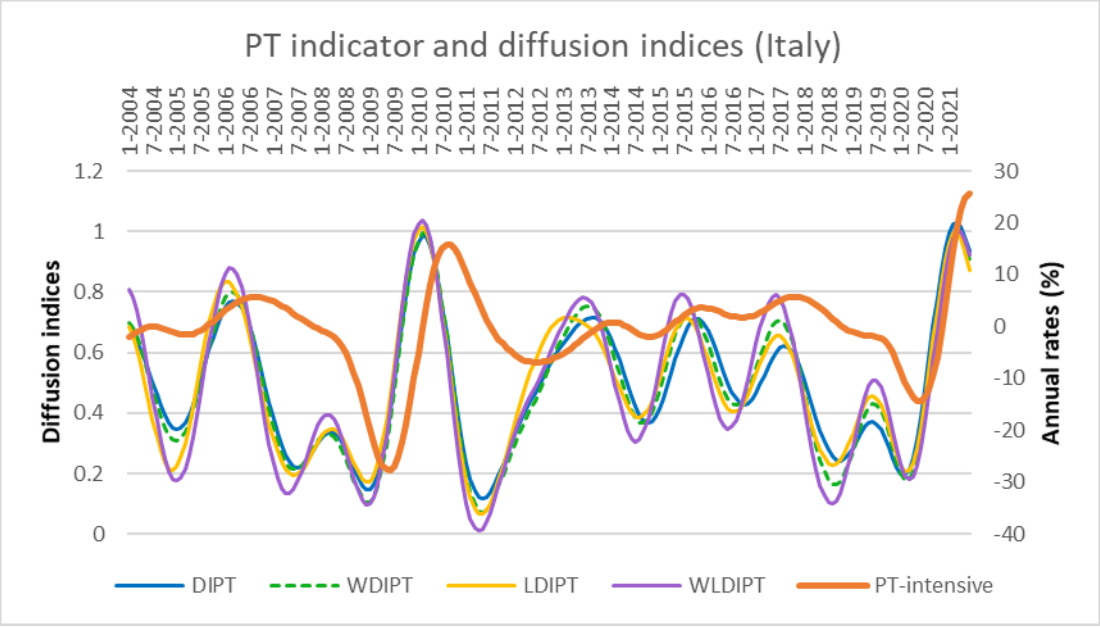
Finally, the maximum annual rate is reached in the last month of the period, June 2021, in France, Italy and Spain, with the highest rate in Italy with a value of +26 %. The minimum rate of the period is always reached in the 2009 trough with Italy ([33]) again showing the highest decline, -28 %, while France shows the lowest decline, -20 %.

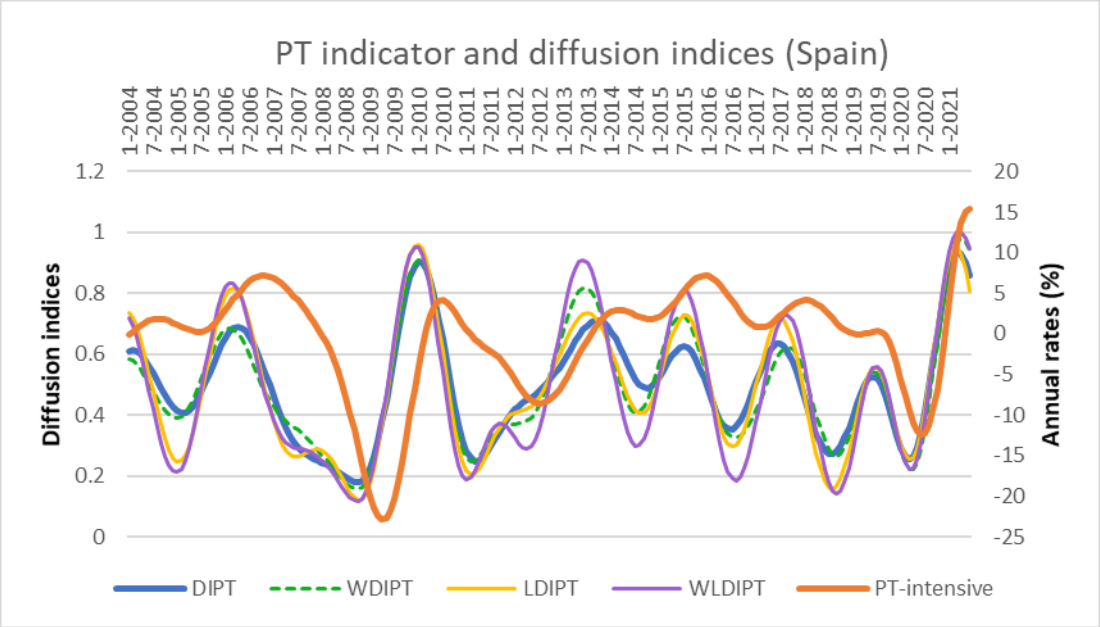
Figure 17 Patent indicators and diffusion indices for the four largest EU Member States (SAR)



([33]) Attention should be paid to the different scale of the Italian patent indicator in Figure 17.


PT indicator and diffusion indices (France)
Diffusion indices
Annual rates (%)
DIPT
WDIPT
LDIPT
WLDIPT
PT-intensive


PT indicator and diffusion indices (Italy)
Diffusion indices
Annual rates (%)
DIPT
WDIPT
LDIPT
WLDIPT
PT-intensive



The four German diffusion indices detected six extra turning points resulting in conformity ratios of 0.86 and 0.63 for the Diffusion Index and 0.86 and 0.59 for the other three diffusion indices, the lowest conformity ratios of all diffusion indices and which is also explained by the low number of turning points detected in the German patent indicator. The German patent indicator, as well as the German design indicator, is more stable than their component series.

The two unweighted indices show higher lead periods and considering the last cycles the Leading Diffusion Index is the preferred one with a median lead period of 6 months of advance and the last peak flagged in April 2020 anticipat a change in the trend of the patent indicator. The two weighted diffusion indices for German patents are the only diffusion indices that do not flag the end of the recovery phase.

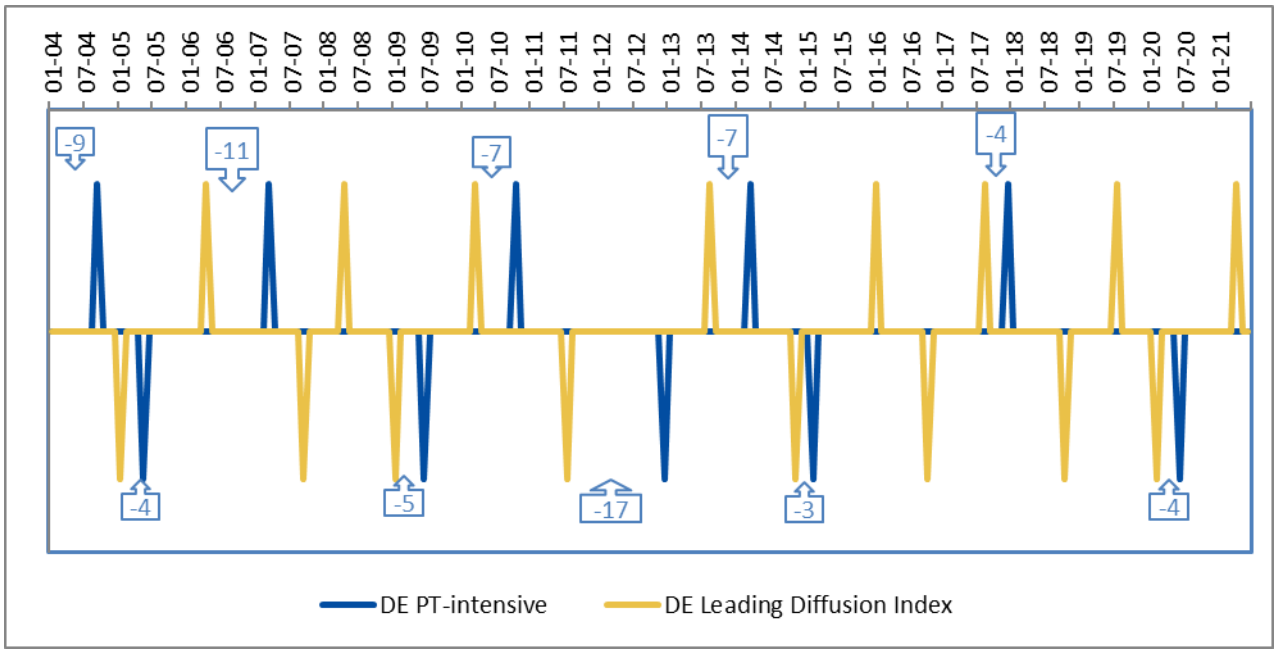
The French indices detected the same turning points as the patent indicator and the conformity ratios are 0.94 and 1 for all of them. The Leading Diffusion Index is the better one with a median lead time of 6 months of advance and the last peak flagged in April 2021 anticipates the end of the current recovery phase.

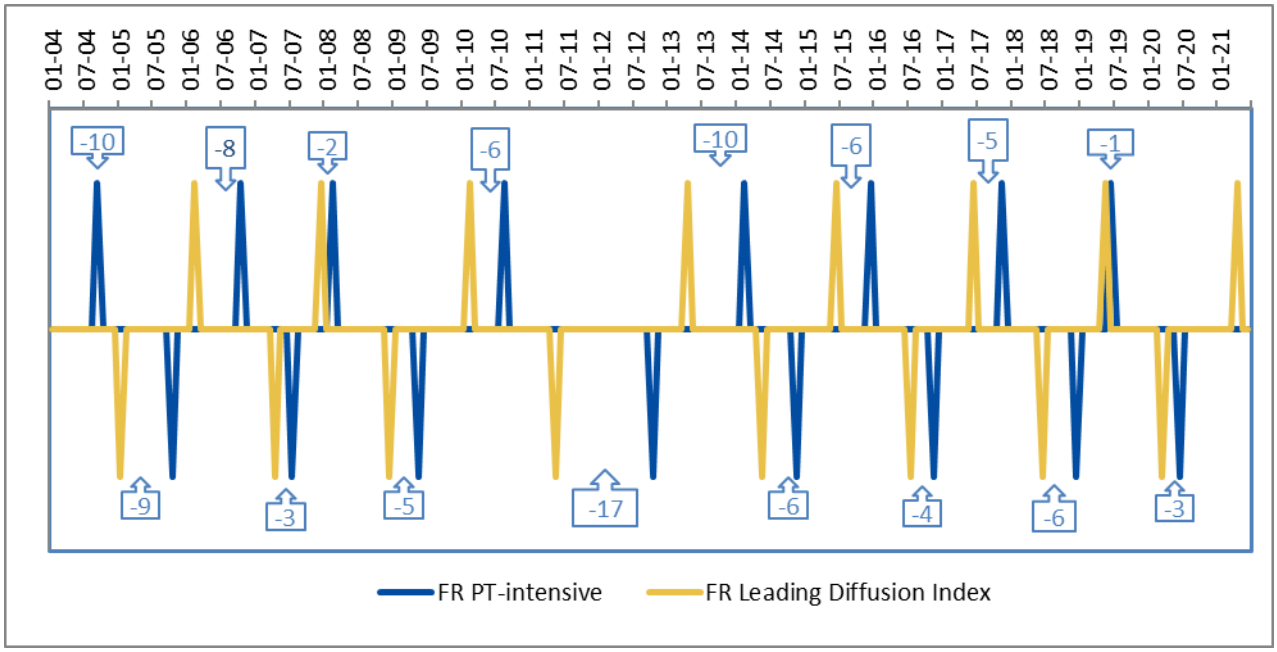
All the Italian diffusion indices flagged four extra (false) turning points and the conformity ratios are 0.86 and 0.75. The better index for the Italian patents is the Weighted Leading Diffusion Index with

a lead time of 5.5 months of advance. All the diffusion indices have flagged the last peak in March 2021.

Finally, the Spanish leading diffusion indices flagged four extra (false) turning points, with conformity ratios of 0.92 and 0.75, while the indices with all the series flagged two extra (false) turning points and their conformity ratios are 0.92 and 0.86. The preferred diffusion index for the Spanish patent-intensive industries based on the lead periods at the end of the period is the Diffusion Index with a median lead period of 6 months of advance and the last peak is detected in March 2021.

Figure 18 Patent indicators and best diffusion indices turning points and lead periods (months) for the four largest MS

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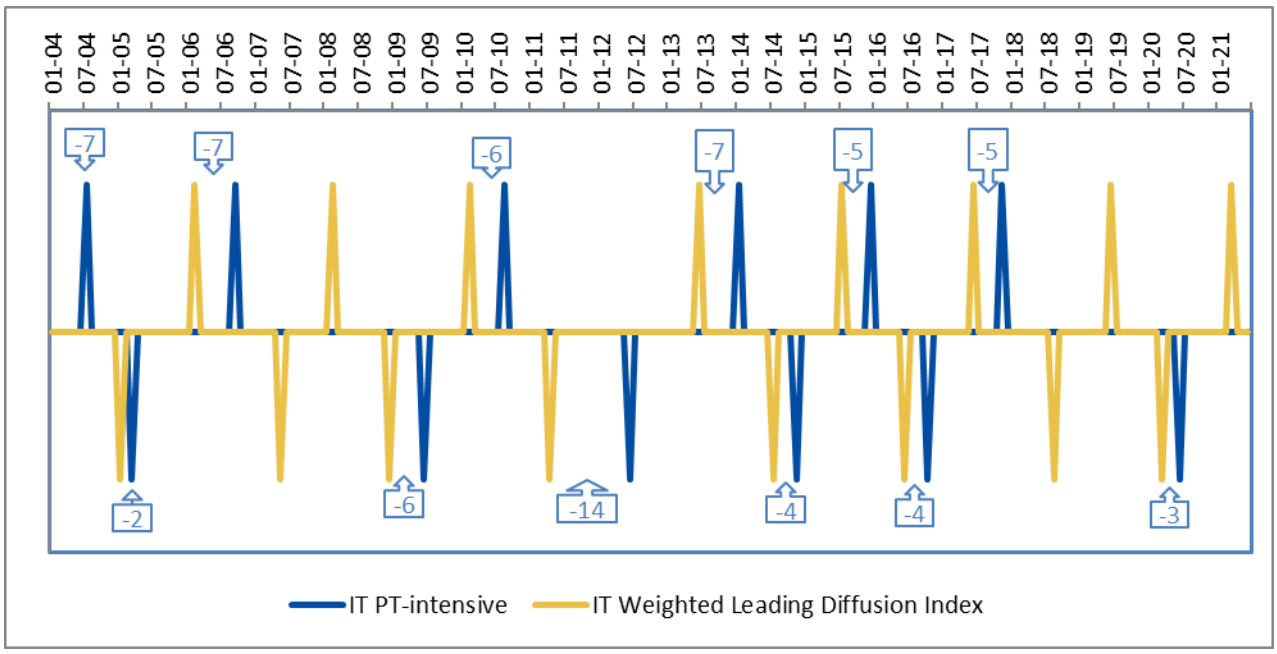
FR PT-intensive
FR Leading Diffusion Index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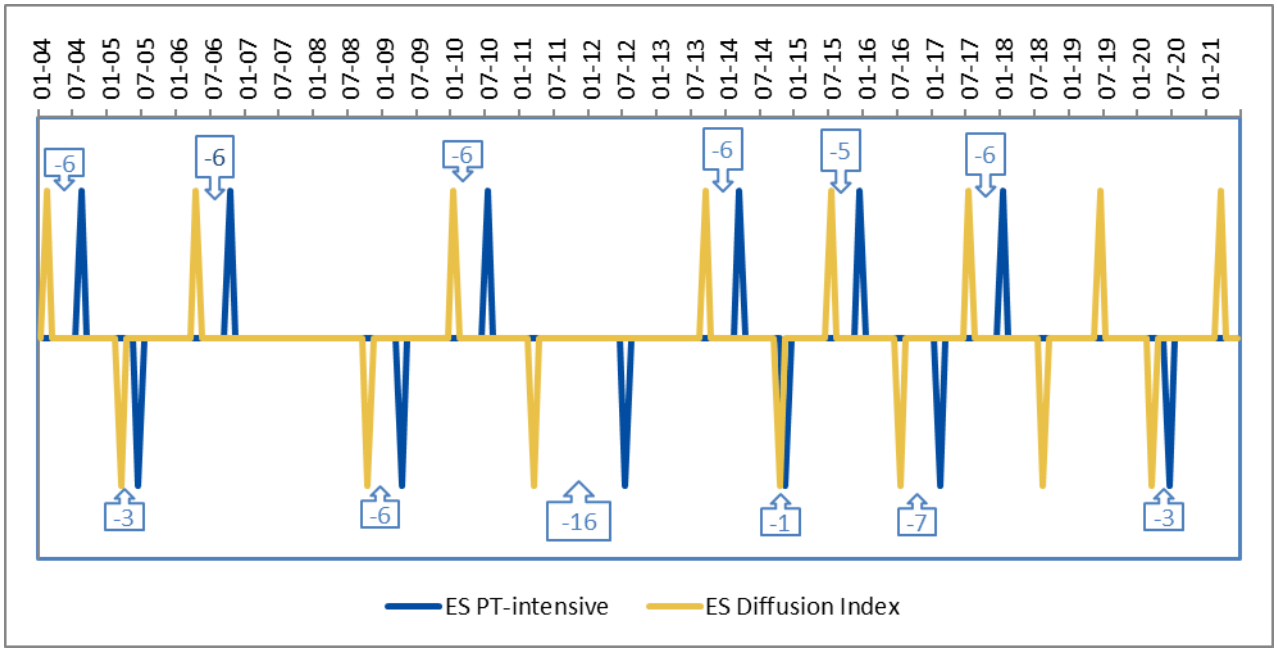
IT PT-intensive
IT Weighted Leading Diffusion Index



The number of patent-intensive industries trending downward in the four largest EU countries was higher in the 2009 financial crisis than in the 2020 crisis. This is shown in the diffusion indices, with the highest difference in Germany with almost 30 % of the design and patent-intensive industries increasing their rates in the worse months of the 2020 crisis compared with less than 17 % and 11 % in 2009 respectively.

5 Conclusions

- This paper presents a set of diffusion indices for the EU and the four largest MS, covering different IPR-intensive industries and using different methods, to anticipate turning points up to 7 months before the events.
- The diffusion indices presented here supplement the analysis of the rates of change of IPR-intensive industries in EUIPO (2021a). They do not provide a quantitative forecast of the aggregates, but they anticipate changes in trends that are especially useful in periods of uncertainty.
- Diffusion indices also show the extent of the recession or recovery phases. They have demonstrated that the 2009 and 2020 crises were spread among most of the IPR-intensive

industries and also that the current recovery phase is spread more among the industries in France, Spain and Italy.

- Leading diffusion indices are proposed using only series that are acceptable based on the two-thirds criterion, and then discarding lagging series. These leading diffusion indices are the preferred ones for all the French indicators and for none of the Spanish indicators as shown in Table 9.
- Weighted diffusion indices consider the different economic importance of the series for the different IPR indicators considered, as well as the different weights in the EU and the four largest MS. These indices are the most appropriate ones to use as diffusion indices for the design indicators for the EU and the three MS.
- There are relevant differences in the four largest EU MS's cycles of the IPR-intensive industries. The maximum annual rate is reached in the last month of the period analysed, June 2021, in all indicators for France, Spain, Italy and the EU average, but for Germany the maximum annual rate is from 2009. The minimum annual rate of the period is reached for all the IPR indicators in 2009.
- Almost all diffusion indices (except the two German weighted diffusion indices) detected a peak in the first half of 2021. This anticipates a slowing down of rates of change for the end of this year.

Table 9 Best diffusion indices and median lead periods (in months) for all IPR indicators in the EU and the four largest MS

	EU	France	Spain	Germany	Italy
IPR	WLDI (-6)	LDI (-6)	DI (-6)		
TM	DI (-5)	LDI (-6.5)	DI (-7)		
DES	WLDI (-6)	WLDI (-6)	WDI (-5.5)	WDI (-6)	
PT	LDI (-6)	LDI (-6)	DI (-6)	LDI (-6)	WLDI (-5.5)

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List of Tables and Figures

Tables

Figures

Acronyms and Abbreviations

COVID-19	Coronavirus disease 2019
CR	Copyright
DE	Germany
DES	Design
DI	Diffusion Index
EPO	European Patent Office
ES	Spain
EU	European Union
EUIPO	European Union Intellectual Property Office
Eurostat	Statistical Office of the European Union
FR	France
GDP	Gross Domestic Product
GVA	Gross Value Added
IGE	Instituto Galego de Estatística
INE	Instituto Nacional de Estadística
IP	Intellectual Property
IPR	Intellectual Property Right
IT	Italy
LDI	Leading Diffusion Index
NACE	Nomenclature statistique des activités économiques dans la Communauté Européenne
NBER	National Bureau of Economic Research
OECD	Organisation for the Economic Co-operation and Development
p.p.	Percentage points
SAR	Smoothed Annual Rate
SBS	Structural Business Survey
STS	Short-Term Business Statistics
TM	Trade mark
VA	Value Added
WDI	Weighted Diffusion Index
WLDI	Weighted Leading Diffusion Index

Appendix: Diffusion Indices Methodology

Diffusion indices are a type of synthetic indicator used for short-term analysis that summarise information on the components of an aggregate. In this paper, the aggregates are the IPR-intensive industries indicators presented in EUIPO (2021a) and the components are the 147 Short Term Statistics (STS) ([34]) series with complete data included in the EU indicator.

A diffusion index is a statistical measure often used to detect economic turning points, which are the points where the series moves from an acceleration phase to a deceleration one (peak) or vice versa (trough). A peak is then the last period of an expansion, while a trough is the last period of a recession. It aggregates multiple indicators by examining whether they are trending upward or downward but ignores the magnitude of the movement. Diffusion indices are used for the monitoring employment, the stock market or to analyse several business cycle indicators.

The diffusion index in a moment t is defined as the percentage of the time series of the aggregate that are trending upward in this period. Considering E_{it} an indicator with value 1 if the growth rate of series i is increasing in month t, and 0 otherwise, the DI_t is the arithmetic mean of the n series included:

$$DI_t = \frac{\sum_i E_{it}}{n}$$

where $E_{it} = 1$ if $T_{it} - T_{it-1} > 0$, T_{it} is the growth rate of series i in month t and T_{it-1} the same rate in moment t-1, otherwise $E_{it} = 0$, and n is the number of series included in the aggregate. The index takes values between 0 and 1.

Based on that, the diffusion index measures the extension of the acceleration or recovery process of the component series. An index close to 1 indicates an increase of the growth rate of most of the series, while an index close to 0 is the consequence of a general process of slowing down of the component series of the aggregated index.

([34]) STS is the earliest statistics released by Eurostat to show emerging trends in the European economy. For more details on this statistics see https://ec.europa.eu/eurostat/web/short-term-business-statistics/overview

One of the limitations of these indices is that all components are treated equally even though it is possible to weight the component series of the aggregate based on their economic importance, resulting in weighted diffusion indices.

Among the advantages of the diffusion index is the simplicity of the calculation and interpretation, as well as the results being available quickly. However, due to its erratic behaviour, it requires a long list of series and the components' growth rates have to be smoothed.

Diffusion indices are leading indicators of an economic aggregate and are used to predict the turning points of the aggregate. The component series of the index will be leading, coincident and lagging. Some series will start to grow (or decrease) before the aggregate, then coincident series will join and finally lagging series. Then, the number of series increasing their growth rate will reach the maximum before the maximum of the aggregate.

The development of the component series of the index is presented in Table 10, where the arrows indicate the sign of the growth of the component series in each period of the cycle.

The aggregate follows a cycle that can be divided in to six phases. The first phase is acceleration ending up in the second phase, when the maximum is reached as is shown in the second row of Table 10. Afterwards there are three phases of slowing down, reaching the minimum in the fifth phase and then in the sixth phase there starts a new recovery.

Table 10 Sign of the growth rates of the component series in the cycle

	I	II	III	IV	V	VI
Leading	↑	↓	↓	↓	↑	↑
Coincident	↑	↑	↓	↓	↓	↑
Lagging	↑	↑	↑	↓	↓	↓

Then, the diffusion index maximum will be reached in phase I, when all series increase their growth rate, while the reference series will reach it at the end of phase II. In the same way, the diffusion index minimum will be in phase IV, before the aggregate which does so in phase V.

As a consequence, the diffusion index will be a leading indicator of the aggregate, independently of the distribution of the components in leading, coincident and lagging, provided that there are series of all three types in the index. A higher proportion of leading series will influence the rhythm of variation of the index and its variance. Finally, the presence of acyclic series (i.e. those series whose phases do not coincide with the aggregate's phases) can distort the relation of the index with the aggregate.

Long-time series since 2001 ([35]) are used to estimate a diffusion index for each of the four IPR indicators: all IPRs ([36]), trade marks, designs and patents. The diffusion index for copyright is not estimated due to the limited number of series, as is shown in Table 10. Finally, we can check whether diffusion indices are leading indicators and the median number of months of advance and see when the next turning point is flagged (and then the beginning of a new recession or recovery phase is predicted).

The first step is to smooth the 147 monthly production STS series to eliminate irregular behaviour and noise in the component series of the index. For the estimation of the SAR, 20 observations are lost at the beginning of the time series, as well as 8 observations at the end, so that 8 forecasts are included in all the series. The forecasts have been estimated with TRAMO software from Banco de España and the automatic procedure for the identification and estimation of ARIMA models with calendar and outliers' corrections.

([35]) Detailed data is available on request.

([36]) Following EUIPO/EPO (2019), the IPR-intensive industries refer to industries that are intensive in the use of trade marks, designs, patents, and copyright, as well as geographical indications (GIs) and plant variety rights (PVR).

The programs <F>, <G> and <FDESC> developed by the Spanish National Statistical Office (INE) for cyclical analysis automatically estimate the SAR and the turning points of the series. Additionally, minimum cycle and phase duration are imposed:

- The duration of the cycle (distance between two consecutive turning points of the same sign) should not be lower than 15 months;
- The duration of the phase (distance between two consecutive turning points of opposed sign) should not be lower than 5 months.

For the cyclical classification, all the turning points are paired off with one and just one turning point of the IPR indicator. The series compared usually have a different number of turning points so that some of them might not have a corresponding pair. For each component series two conformity ratios are defined: one as the number of paired turning points divided by the total number of turning points of the reference series (IPR indicator) and the other as the number of paired turning points divided by the total number of turning points of the classified series. The minimum conformity ratio is fixed at 0.6 so that all component series with lower ratios are classified as acyclic.

For those series with a conformity ratio of at least 0.6, the lead time is defined as the distance in months between paired turning points and it is used to determinate whether the series is coincident (between 0 and 3 months of lead time), leading (turning points flagged with more than 3 months of median advance) or lagging (median delay of more than 3 months).

A total of 147 series with complete data are classified with reference to the IPR indicator as leading, coincident, lagging or acyclic. For trade mark, design, patent and copyright indicators the classification of component series is also included in Table 11.

Table 11 Classification of series with reference to the IPR indicators

	Leading	Coincident	Lagging	Acyclic	Total
IPR	8	123	15	1	**147**
TM	7	102	8	4	**117**
DES	3	92	9	0	**104**
PT	5	77	6	0	**88**
CR	2	17	0	1	**20**

It must be stressed that turning points of the four IPR indicators are different so that a series can be classified differently in relation to each IPR. For instance, division 58 ([37]) is classified as a coincident series when it is compared with the trade mark and copyright indicators but it is a lagging indicator in relation to all IPRs, patents and designs.

Leading series from IPR indicators are all in the manufacturing sector except NACE division 61 ([38]), which is in the service sector (intensive in trade marks, designs, patents and copyright). This series is lagging when compared with the trade mark indicator, leading in comparison with design and patent indicators and coincident with the copyright-intensive industries' cycles.

The TM indicator is the one with more acyclic series with seven leading series belonging to the manufacturing sector.

There are only 20 series with complete data to estimate a diffusion index for the copyright-intensive industries. Only one series is acyclic based on a conformity ratio of 0.6, therefore diffusion indices for the copyright indicator are not estimated in this paper.

The diffusion indices are subsequently filtered with the SAR filter of program <F> to obtain smoother indicators and compared with the SAR of the composite indicator for all IPRs.

([37]) NACE 58 'Publishing activities'.
([38]) NACE 61 'Telecommunications'.

Additionally, weighted diffusion indices have been estimated with weights based on the VA of each series from the Structural Business Statistics (SBS) in 2015.

The second type of diffusion indices presented in this paper are based only on series that comply with Moore's criterion: at least two thirds of the indicator's turning points lead or coincide with the reference (IPR indicators) turning points. Two diffusion indices based only on acceptable series have been estimated: Leading Diffusion Index and Weighted Leading Diffusion Index. The acceptable series are those that have at least two thirds of its troughs flagged in advance or with a maximum of 3 months of delay when compared with the corresponding IPR indicator. The series that comply with the two-thirds criterion when both peaks and troughs are considered are also acceptable. Table 12 shows the number of turning points paired with a maximum of 3 months delay for all the IPR indicators for the acceptable series.

Table 12 Number of acceptable series (two-thirds criterion) by number of turning points paired

	6	7	8	9	10	11	12	13	14	Total
IPR	1	4	7	19	21	23	10	3	0	**88**
TM	7	15	26	25	8	14	1			**98**
DES	0	0	4	11	11	11	6	4	0	**47**
PT	0	1	6	6	13	9	7	2	0	**44**

Median turning points paired for acceptable series are 10 out of 14 (71 %) for all IPRs, and design- and patent-intensive industries and 9 out of 12 (75 %) for trade mark intensive industries.

The same four diffusion indices have been estimated for the four largest EU Member States and for the IPR indicators with enough data. The cyclical classification of the series in relation with the corresponding IPR indicator is presented in Table 13.

Table 13 Classification of series with reference to the IPR indicators in the four largest MS

	MS	Leading	Coincident	Lagging	Acyclic	Total
IPR	**France**	31	134	5	7	**177**
	Spain	14	138	20	1	**173**
TM	**France**	15	117	7	2	**141**
	Spain	15	104	19	1	**139**
DES	**Germany**	9	75	19	36	**139**
	France	16	100	4	1	**121**
	Spain	5	100	12	1	**118**
PT	**Germany**	6	98	13	5	**122**
	France	11	92	4	1	**108**
	Italy	2	82	8	0	**92**
	Spain	13	71	12	2	**98**

All the diffusion indices presented for the MS have more series than the corresponding index for the EU. France and Spain have a similar number of series allowing estimates to be made of the diffusion indices for the four IPRs. All French and Spanish diffusion indices for all IPRs have 30 series more than the corresponding EU diffusion indices. What is remarkable is also the presence of more than 30 leading series in the French IPR diffusion indices and more than 10 % of leading series in the trade mark, design and patent diffusion indices.

The German designs diffusion indices also have 30 series more than the EU indices and the patent diffusion indices 40 series more than the EU (although there is no service sector series available for Germany). Nevertheless, the presence of 36 acyclic series in the German design indices could worsen the cyclical relationship between the aggregate and the diffusion indices.

For the estimation of the weighted diffusion indices each MS applies different weights. To summarise the different economic importance of the main sectors by IPR and MS, Table 14 presents the weights applied to the manufacturing, wholesale and service sectors indicators.

Table 14 Weights (%) applied to main sectors of IPR indicators for the EU and the four largest Member States.

(in %)		IPR	TM	DES	PT	CR
EU27	Manufacturing	58.0	54.9	71.4	93.0	7.5
	Wholesale	18.5	22.9	20.0		
	Services	23.5	22.2	8.6	7.0	92.5
Germany	Manufacturing	68.3	63.9	81.4	97.1	9.1
	Wholesale	13.9	17.5	13.6		
	Services	17.8	18.5	5.0	2.9	90.9
France	Manufacturing	51.0	50.2	64.2	91.5	5.0
	Wholesale	21.0	27.9	29.6		
	Services	28.0	21.9	6.2	8.5	95.0
Italy	Manufacturing	60.3	57.3	73.6	94.1	9.3
	Wholesale	19.8	24.2	19.1		
	Services	19.8	18.6	7.3	5.9	90.7
Spain	Manufacturing	56.0	54.9	70.3	95.1	8.3
	Wholesale	21.2	26.7	22.5		
	Services	22.8	18.4	7.2	4.9	91.7

Finally, the acceptable series based on the two-thirds criterion are shown in Table 15 classified by the number of turning points paired. The median number of turning points detected by the component series ranges between 70 % and 80 % of the total number of turning points of the reference series with the maximum of 80 % detected by French IPR-intensive industries and German design-intensive series.

Table 15 Number of acceptable series (two-thirds criterion) by number of turning points paired.

		Median	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
France	**IPR**	12					4	2	24	20	20	17	6	9			**102**
	TM	10			1	2	6	21	19	14	13	7					**83**
	DES	12.5						1	8	7	17	13	10	8	1	1	**66**
	PT	13						1	4	12	10	15	11	9	0	3	**65**
Spain	**IPR**	11		4				7	22	14	12	9	5	0			**73**
	TM	11					1	5	19	11	14	10	2	0			**62**
	DES	10				3	4	19	17	15	9	7	0				**74**
	PT	10				2	5	12	16	11	9	10					**65**
Germany	**DES**	8	1	1	2	27	22	37	4								**94**
	PT	9		1	2	10	26	20	17	6	0						**82**
Italy	**PT**	10				3	3	14	10	15	6	3	0				**54**

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