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Data Article

The global patents dataset on the vehicle powertrains of ICEV, HEV, and BEV

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ABSTRACT

Patent bibliometrics data are the most reliable business performance metric for applied research and development activities when investigating the knowledge domains or the technological evolution of vehicle powertrain technologies in the automotive industry. Our paper describes a global patents dataset for the internal combustion engine vehicles (ICEV), hybrid electric vehicles (HEV) and battery electric vehicles (BEV) over 1985–2016. We extracted the patents granted in each powertrain field from Thomson Reuters' Derwent Innovations Index (DII). We applied a combined search strategy of international patent classifications (IPCs) and keywords as well as 'patent families' and 'priority dates' to construct our global patents dataset. This strategy returned a total of 78,732 patents, within which we identified 49,154 ICEV patents; 10,888 HEV patents; and 18,690 BEV patents. Our database includes numerous descriptive features of each patent such as title, abstract, claim, priority, application and publication dates, IPCs, assignees/applicants, inventors, and cited references. These data are associated with the research article 'The evolution of dynamic interactions between the knowledge development of powertrain systems' [1]. The full dataset, which is attached to this article, may be useful to both researchers and practitioners interested in investigating,

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modelling or forecasting the complexity and evolution of the technical and knowledge domains of the vehicle powertrains, across a variety of instruments such as social network analysis and regression models.

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Specifications table

Subject	Transportation, Management of Technology and Innovation
Specific subject area	Vehicle powertrains, Electric vehicles, Patent bibliometrics
Type of data	CSV files, and tables in the article.
How data were acquired	Thomson Reuters' Derwent Innovations Index.
Data format	Raw and processed data.
Parameters for data collection	We collected and contracted a global patents dataset on ICEV, HEV, and BEV over 1985–2016. The database was extracted and processed using a combined search strategy of IPCs and keywords and IPCs codes as well as 'patent families' and 'priority dates.'
Description of data collection	Of the total of 78,732 patents, we located 49,154 patents in the ICEV technological field, 10,888 patents in the HEV field, and 18,690 patents for the BEV field. Patents are described in terms of various features such as title, abstract, claim, priority, application and publication date, IPCs, assignees/applicants, inventors, and cited references.
Data source location	The University of Newcastle, 409 Hunter Street, Newcastle, NSW, 2300, Australia
Data accessibility	With the article
Related research article	Mirzadeh Phirouzabadi, A., Savage, D., Blackmore, K. & Juniper, J. (2020) 'The evolution of dynamic interactions between the knowledge development of powertrain systems'. <i>Transp. Policy</i> , 931–16. https://doi.org/10.1016/j.tranpol.2020.04.018 .

Value of the data

- A global patents database is documented on ICEV, HEV, and BEV over 1985–2016.
- The full dataset describes every patent in terms of descriptive features such as publication number, title, abstract, claim, priority date, application date, publication date, IPC codes, assignees/applicants, inventors, and cited references.
- Applying a variety of instruments such as social network analysis and regression models, researchers can exploit the full patents dataset not only for investigating and modelling their global knowledge dynamics and structures, but also for forecasting their evolutionary advancements.
- The granted patents in other powertrain technological fields can extend our database.

1. Data

A global patents database, used in [1], documents the patents granted in the powertrain technological field of internal combustion engine vehicle (ICEV), hybrid electric vehicle (HEV) and battery electric vehicle (BEV) over 1985–2016. While these vehicle powertrains are satisfying the same transportation need of modern society, they are different in terms of comprising components. The ICEV powertrain is comprised of the core components of combustion engine, fuel tank, fuel system, exhaust system and transmission. The BEV powertrain, on the other hand, is comprised of the core components of battery packs, battery charger, power convertor and con-

Table 1

The absolute, relative and cumulative number of patents in each powertrain technological field (1985–2016).

Year	Absolute number			Relative number			Cumulative number		
	BEV	HEV	ICEV	BEV	HEV	ICEV	BEV	HEV	ICEV
1985	3	2	318	0.93%	0.62%	98.45%	3	2	318
1986	1	1	329	0.30%	0.30%	99.40%	4	3	647
1987	2	1	379	0.52%	0.26%	99.21%	6	4	1026
1988	8	1	338	2.31%	0.29%	97.41%	14	5	1364
1989	9	2	396	2.21%	0.49%	97.30%	23	7	1760
1990	16	3	491	3.14%	0.59%	96.27%	39	10	2251
1991	31	6	504	5.73%	1.11%	93.16%	70	16	2755
1992	59	20	506	10.09%	3.42%	86.50%	129	36	3261
1993	84	19	546	12.94%	2.93%	84.13%	213	55	3807
1994	135	43	643	16.44%	5.24%	78.32%	348	98	4450
1995	109	80	830	10.70%	7.85%	81.45%	457	178	5280
1996	138	84	920	12.08%	7.36%	80.56%	595	262	6200
1997	196	157	1041	14.06%	11.26%	74.68%	791	419	7241
1998	209	229	1131	13.32%	14.60%	72.08%	1000	648	8372
1999	254	220	1169	15.46%	13.39%	71.15%	1254	868	9541
2000	251	233	1455	12.94%	12.02%	75.04%	1505	1101	10,996
2001	268	254	1481	13.38%	12.68%	73.94%	1773	1355	12,477
2002	271	295	1629	12.35%	13.44%	74.21%	2044	1650	14,106
2003	327	377	2094	11.69%	13.47%	74.84%	2371	2027	16,200
2004	422	390	1851	15.85%	14.65%	69.51%	2793	2417	18,051
2005	470	472	2307	14.47%	14.53%	71.01%	3263	2889	20,358
2006	616	587	2800	15.39%	14.66%	69.95%	3879	3476	23,158
2007	686	666	2847	16.34%	15.86%	67.80%	4565	4142	26,005
2008	824	622	3150	17.93%	13.53%	68.54%	5389	4764	29,155
2009	1183	736	2806	25.04%	15.58%	59.39%	6572	5500	31,961
2010	1789	876	3097	31.05%	15.20%	53.75%	8361	6376	35,058
2011	2433	1009	3406	35.53%	14.73%	49.74%	10,794	7385	38,464
2012	2508	1019	3367	36.38%	14.78%	48.84%	13,302	8404	41,831
2013	2166	908	2957	35.91%	15.06%	49.03%	15,468	9312	44,788
2014	1825	736	2195	38.37%	15.48%	46.15%	17,293	10,048	46,983
2015	926	529	1396	32.48%	18.55%	48.97%	18,219	10,577	48,379
2016	471	311	775	30.25%	19.97%	49.78%	18,690	10,888	49,154
Sum	18,690	10,888	49,154	23.74%	13.83%	62.43%	-	-	-
Total	78,732								

troller, and traction motor. The HEV powertrain crossovers both the ICEV and BEV powertrains and hybridises their components in a smaller version [2].

Over the period of 1985–2016, a total of 78,732 patents were located in the technological field of all the three powertrains; 49,154 patents in the ICEV field; 10,888 patents in the HEV field; and 18,690 patents in the BEV field. Table 1 show the absolute, relative and cumulative number of patents that were annually granted in each technological field. The Supplementary Appendix includes an Excel file which contains the absolute, relative and cumulative number of patents presented in the table.

Another Excel file has been included in the Supplementary Appendix which lists every single patent in terms of the following descriptive features¹ [3].

- Title: a patent's title is a precise, concise descriptive English statement about the main content of the invention.
- Abstract: a patent's abstract is a brief (250–500 words) summary of the content, novelty, claims and disclosures of the invention in English.
- Claim: a patent's claim defines the subject matter and the protection boundaries (i.e. the extent or scope of protection) in terms of technical features that can be legally enforceable.

¹ For each patent in the dataset, a link as well as a PDF copy has been provided that contain and show all the descriptive features online.

- Application number: a patent's application number refers to a local filing number that is assigned to the patent document by the patent office once the application is legally accepted. It initiates with a two-character code of the country within which the application is filed.
- Application date: a patent's application date refers to the date on which an application for the invention is legally accepted in a patent office, only if the least filing requirements are fulfilled.
- Publication number: a patent's publication number refers to a serial number assigned to the patent after its publication, which initiates with a two-character code of the country the patent is published.
- Publication date: a patent's publication date refers to the date on which the patent documents have been publicly disclosed.
- Priority date: since it's legal to file separate applications for the same invention with different patent offices around the world, the mention of priority date in a patent refers to the original application date or the date on which the invention was originally filed in a patent office.
- International Patent Classification: it is an international system of hierarchical language independent symbols that classify patents in accordance with their technical domains and fields.
- Inventor(s): the mention of inventor(s) in a patent refers to the person(s) who contributed to the conception of the invention.
- Assignee(s)/applicant(s): the mention of assignee(s)/or applicant(s) in a patent refers to the individual(s) or organisation(s) recognised as the legal recipient(s) of all or limited rights of the patent.
- Cited references: cited references in a patent refer to those patents that have been used and cited by the inventor(s) in the patent documents.

2. Experimental design, materials, and methods

We acquired the patents granted in each powertrain field from Thomson Reuters' Derwent Innovations Index (DII) [3]. It is recognised as one of the most comprehensive patent databases in the world [4–6]. We collected the data in November 2018, and the database covers the period of 1985–2016. We extracted the data using a combined search strategy of IPC codes and keywords recommended by [5,6] as well as 'priority dates' and 'patent families.' Our combined search strategy is shown in Table 2. Not only we diminished the chance of including any patents unrelated to a technological field through keywords and IPCs [4–6], but also through the DII feature of 'patent families²' we avoided the multiple counting of the same inventions which are usually filed in various national patenting systems [4,5,7]. The extracted patents were eventually ordered based upon the earliest priority date³ in patent families.

We assured the quality of the patents database by a manual check for at least 5% of the database [4]; 2460 patents in the ICEV field; 545 patents in the HEV field; and 940 patents in the BEV field [5,6]. A patent was considered valid in a technological field if the claim of the patent could contain "... the categorized technology as well as the possibility of an automotive utilization" [4, p79]. The results of the manual validity check reached a good performance since for all the powertrain fields the performance was above 85.00% [4]; 87.25% for the ICEV field; 89.80% for the HEV field; and 88.25% for the BEV field [5,6].

² "A patent family pools all patent applications that are made in different countries for the same invention by a common inventor" [4, p78].

³ With the use of the priority date of a patent it is unnecessary to include any additional lags to offset the pendency matter (18 months on average). This is because the priority date depicts the closest date to the submission of the invention [8].

Table 2

The combined search strategy adopted from [5, 6].

Keywords and IPC as well as priority dates	
The ICEV powertrain	<ul style="list-style-type: none"> • Keywords in title and abstract: ((automobile* OR vehicle* OR car*) AND ("internal combustion engine*" OR "diesel engine*" OR "IC engine*")) • IPC codes: (F01* OR B60* OR F02B* OR F02D* OR F02F* OR F02M* OR F02N* OR F02P*) • Time Span: priority dates set to between January 1st, 1985 and December 31st, 2016.
The BEV- powertrain	<ul style="list-style-type: none"> • Keywords in title and abstract: ((automobile* OR vehicle* OR car*) AND ("electric vehicle" OR "electric automobile" OR "electric car") AND (battery OR batteries)) • IPC codes: (H02k* OR H01M* OR B60L011* OR B60L003* OR B60L015* OR B60K00101* OR B60W001008 OR B60W001024 OR B60W001026) • Time Span: priority dates set to between January 1st, 1985 and December 31st, 2016.
The HEV powertrain	<ul style="list-style-type: none"> • Keywords in title and abstract: ("hybrid propulsion" OR "hybrid electric vehicle*" OR "hybrid vehicle*" OR "hybrid automobile*" OR "hybrid electric car*" OR "hybrid car*") • IPC codes: (F02* OR F16H* OR B60K006* OR B60W020 OR B60L00071* OR B60L000720) • Time Span: priority dates set to between January 1st, 1985 and December 31st, 2016.

Declaration of Competing Interest

None.

CRedit authorship contribution statement

Amir Mirzadeh Phirouzabadi: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Validation, Visualization, Writing - original draft, Writing - review & editing. **David Savage:** Conceptualization, Methodology, Project administration, Resources, Supervision, Writing - review & editing. **Karen Blackmore:** Conceptualization, Methodology, Project administration, Resources, Supervision. **James Juniper:** Conceptualization, Methodology, Supervision.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.dib.2020.106042](https://doi.org/10.1016/j.dib.2020.106042).

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