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# The disappearance of the zero-earnings discontinuity: SOX, dotcom boom or gradual decline?

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ABSTRACT

The zero-earnings discontinuity in the US disappeared around the time when the Sarbanes–Oxley Act (SOX) became effective, suggesting that SOX may have reduced the small loss avoidance by firms. In this paper, we examine a potential confounding effect arising from the dotcom boom at the turn of the millennium. Many newly listed dotcom firms had no revenues but high market capitalizations. Therefore, they mechanically fell into the smallest loss interval, artificially reducing the zero-earnings discontinuity. Once this dotcom effect is accounted for, our results no longer suggest a sharp (causal) effect of SOX on the decline in the zero-earnings discontinuity.

## 1. Introduction

Burgstahler and Dichev (1997) show that the frequency distribution of earnings scaled by the lagged market value of equity shows a discontinuity at zero, indicating that many firms report small profits, while few firms report small losses. This phenomenon is known as the zero-earnings (ZE) discontinuity or ZE kink. Numerous studies in several countries have confirmed the discontinuity.[1] Although different explanations for the ZE kink have been proposed, “the theory that earnings are managed to meet benchmarks provides the most simple and complete explanation for the body of evidence” (Burgstahler and Chuk, 2017, p. 744).[2]

Interestingly, Gilliam et al. (2015) show that the ZE kink has disappeared in the United States (US), which is of great interest to regulators and researchers.[3] Gilliam et al. (2015, p. 188) “are able to identify a critical turning point when the zero-earnings discontinuity becomes imperceptible”. This turning point is the year 2002, which “is consistent with ... a decline in loss avoidance after SOX” (p. 188). It is also “consistent with prior research suggesting SOX reduced accrual earnings management” (p. 124).[4] It therefore appears that SOX had a real and lasting impact on earnings management in line with the regulation’s general objective to improve the reliability of financial reporting.[5]

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[1] See, e.g., Degeorge et al. (1999), Dechow et al. (2003), Burgstahler and Eames (2006), Leuz et al. (2003), Burgstahler et al. (2006), Gore et al. (2007), Daske et al. (2006), and Burgstahler and Chuk (2017).

[2] For the alternative explanations, see Durtschi and Easton (2005, 2009).

[3] The results are different in other countries. See, e.g., Enomoto and Yamaguchi (2017) for Japan.

[4] Gilliam et al. (2015) refer to Bartov and Cohen (2009), Cohen et al. (2008), Lobo and Zhou (2006, 2010). See Chung et al. (2009) for the impact of SOX on the relation between earnings management and equity liquidity and Chen et al. (2020) for country factors in earnings management of ADR firms.

[5] See Amar et al. (2021) for evidence on the motives of financial misconduct.

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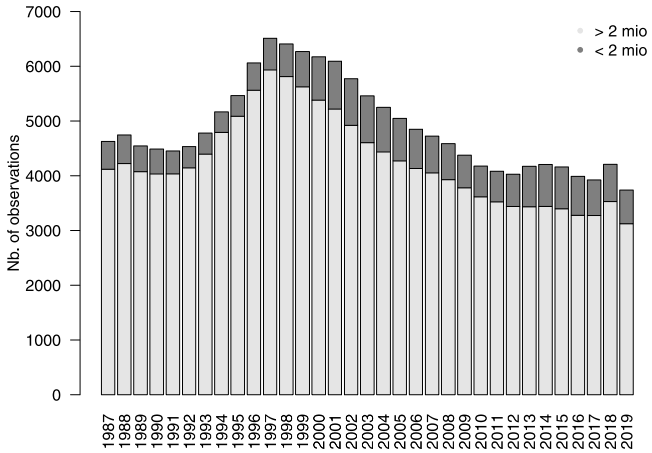


**Fig. 1. Sample size by year (1987–2019).** The two categories are (1) Total sales greater than 2 million USD (lightgrey), and (2) Total sales less than 2 million USD (darkgrey).

While the time of the turning point appears to be narrowly defined, Gilliam et al. (2015, p. 199) ''caution that passage of SOX is not the only important event occurring during our time period of interest that may have affected the discontinuity. Examples include the collapse of Enron in 2001, the registration of US firms with the PCAOB in 2003, and the global investment settlement in 2003''.

We identify the dotcom boom as another potential confounder that has not yet been considered in prior literature. In the second half of the 1990s, many firms with sales revenues close to zero went public and were added to financial databases. Without revenues, they inevitably suffered losses that were often small in relation to the high market values of equity at the peak of the dotcom boom. Therefore, small losses occurred much more often than small profits in this group, which apparently reduced the ZE discontinuity in the overall sample. However, this reduction was mechanically driven by the addition of the dotcom firms to the sample, rather than a true decline in earnings management. As these events occurred around the turn of the millennium, their impact might be confounded with the effect of SOX in 2002. Therefore, the objective of this research note is to examine the role of the dotcom effect in explaining the observed decline in the ZE discontinuity over time.

Our empirical findings show that once the dotcom effect is accounted for, there is no sharp decline in the ZE discontinuity when SOX was introduced; rather, the decline is gradual over time. As this evidence does not suggest a causal effect of SOX on the ZE discontinuity, our findings contribute to the literature that investigates the effects of SOX. In addition, our findings have implications for regulators and policymakers in assessing the costs and benefits of SOX, lest they overestimate the disciplinary effect of SOX on earnings management.

## 2. Data and method

### 2.1. Data

We use merged CRSP and Compustat data of US firms from 1987 to 2019. We exclude firms in regulated industries and financial institutions with SIC codes ranging from 4400 to 5000 and 6000 to 7000.[6] We require net income and total sales to be available. The beginning of the year market value of equity and total assets must be larger than zero. Following previous research, we remove observations with a net income of exactly zero (47 firm-years).[7] Net income is the bottom line position that includes operating and nonoperating income after extraordinary items (Compustat item NI). It is scaled by the beginning of the year market value of equity (Compustat item CSHO*PRCC_F). The final sample contains 161,072 firm-years. Fig. 1 shows the distribution over the years.

To capture the dotcom effect, we identify firms without substantial revenues by using a threshold for total sales of 2 million USD. We do not set the limit at zero in order to also capture firms with slightly positive sales that are not economically important. Our results are robust with respect to the exact threshold at least in a range of 0 to 10 million USD. Overall, the percentage of firms without substantial sales is 12.7%. Fig. 1 shows the distribution over time (dark gray). The proportion rises from a low of 6.9% in 1995 to 15.7% in 2003 and a maximum of 18.4% in 2014. Note that not all firms can be classified as ''dotcom firms'' even if they went public during the dotcom boom. There is, for example, an important group of firms engaged in biotechnology and pharmaceutical research.

[6] See, e.g. Beaver et al. (2007), Brown and Caylor (2005), Burgstahler and Dichev (1997), Chen et al. (2010), Durtschi and Easton (2005, 2009), Gilliam et al. (2015), Haga et al. (2019), Kerstein and Rai (2007), Roychowdhury (2006), Makarem et al. (2018) and Li (2019).

[7] See Burgstahler and Dichev (1997), Gilliam et al. (2015), Dechow et al. (2003), Beaver et al. (2007), Burgstahler and Eames (2006), and Lahr (2014).

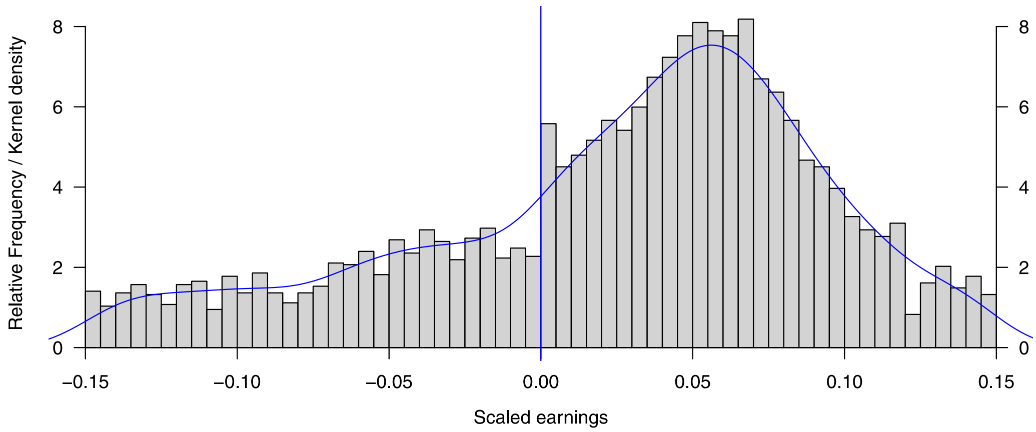


**Fig. 2. Illustration of kernel density estimation (1997, all firms).** For interval width 0.005, we have: $SLD = -0.36$ and $SPD = 0.40$. This means that the number of observations in the first loss (profit) interval is 36% smaller (40% larger) than expected according to the kernel density (in blue). For interval width 0.015, we have: $SLD = -0.28$ and $SPD = 0.13$. This means that the discontinuity is smaller when the three first profit intervals and the three first loss intervals (of width 0.005 each) are taken together.

### *2.2. Discontinuity measures*

As in most of the literature, our primary earnings measure is net income scaled by the market value of equity at the beginning of the fiscal year. As a robustness check, we use total assets as a scaling variable.

A first commonly used discontinuity measure is the standardized difference between the actual number of observations in the smallest loss interval and the expected number of observations assuming no discontinuity. Formally, $SD_{-1} = \left[N_{-1} - 0.5(N_{-2} + N_1)\right] / s_{-1}$, where $N_{-1}$ is the number of observations in the smallest loss interval, $N_{-2}$ and $N_1$ are the numbers of observations in the neighboring intervals to the left and right, respectively, and $s_{-1}$ is the standard error of the difference.[8] The standardized difference for the first profit interval, $SD_1$, is defined analogously. A second commonly used measure is the profit-to-loss ratio. It is defined as the ratio of the number of observations in the first profit and loss intervals: $PL = N_1/N_{-1}$ (Dechow et al., 2003). In the presence of a ZE discontinuity, $SD_{-1}$ will be negative, $SD_1$ will be positive and $PL$ will be larger than 1.

Both measures have certain weaknesses. For a given level of the discontinuity, the $SD$ statistic increases as the sample size increases. This blending of the effect size and test power is undesirable in comparisons over time when the sample size varies. Specifically, when the sample size is small in early years, $SD_{-1}$ and $SD_1$ will underestimate the potential decline in the ZE discontinuity. Another critical aspect is that the expected frequency is defined as the average frequency of the adjacent intervals. When these in turn are distorted, the statistic is difficult to interpret. Furthermore, in the case of a positive mean of scaled earnings, the normal profit-to-loss ratio (without a ZE discontinuity) is already greater than 1.

To avoid these weaknesses, we modify the two measures by using a kernel density estimation inspired by Lahr (2014). Our purpose is not to estimate the complete density but to find a smooth representation of the frequency distribution in the relevant area. Therefore, we only include scaled earnings of $-0.15$ to $0.15$. As the time pattern of the estimated discontinuity is almost the same for different versions of kernel estimators, we apply a standard Gaussian estimator.[9] Fig. 2 shows an example (data for 1997 with a substantial ZE discontinuity). Our measure "small loss deviation" is defined as $SLD = (Actual_{-1} - Expected_{-1})/Expected_{-1}$, where $Actual_{-1}$ is the actual number of observations in the first loss interval and $Expected_{-1}$ is the expected number according to the kernel density estimation (integral over the first loss interval). The "small profit deviation" is analogously defined as $SPD = (Actual_1 - Expected_1)/Expected_1$, where subscript 1 represents the first profit interval. Our modified profit-to-loss ratio $MPL$ is defined as $MPL = ln\left[N_1/N_{-1}\right] - ln\left(EPLR_1\right)$, where $EPLR$ is the expected profit-to-loss ratio without discontinuity (integral of the kernel density over the first profit interval divided by the integral over the first loss interval).

To allow comparison with previous results, we use the same interval widths of 0.005 and 0.015 as Gilliam et al. (2015). In the case of the interval width 0.015, the observations of the first three loss and profit intervals of width 0.005 are compared to the expected value according to the kernel density over the same range.

## 3. Empirical results: The zero earnings discontinuity over time

To track the change in the ZE discontinuity over time, we compute the small loss difference $SLD$ and the small profit difference $SPD$ on a yearly basis and show the results in Fig. 3. The graphs on the left and right are based on interval widths of 0.005 and

[8] The standard error is computed as $s_{-1} = \sqrt{Np_{-1}\left(1-p_{-1}\right) + 0.25N\left(p_{-2}+p_1\right)\left(1-p_{-2}-p_1\right)}$, where $p_i$ is the proportion of observations falling in interval $i$.

[9] The density is estimated at 512 equally spaced points. We implement the estimation in R ("density" function) with the bandwidth proposed by Scott (1992) (option bw.nrd in R).

0.015, respectively. For scaling with the market value of equity (MVE), the upper panels (A1 and A2) represent the total sample and the middle panels (B1 and B2) represent the subsample of firms with sales revenues greater than 2 million USD in the respective year. The graphs in the bottom panels (C1 and C2) show results for scaling with total assets (so that scaled earnings correspond to the return on assets, ROA). The year 2001 is marked by a vertical line because it is the year before SOX was enacted (on July 30, 2002).

Before 1995, half of the expected number of cases in the narrow loss interval are "missing", indicating a pronounced discontinuity ($SLD \approx -0.5$; graph A1), which is consistent with prior studies (e.g., Degeorge et al., 1999; Dechow et al., 2003; Burgstahler and Eames, 2006; Leuz et al., 2003). From 1995 to 2006, $SLD$ shows an upward trend, with a spike in 2000 to a level of zero. After 2006, $SLD$ stays mainly negative without a clear trend. This overall pattern is reflected in the downward trend of the small profit difference $SPD$. The absolute values of $SPD$ are generally smaller than those of $SLD$, which means that the missing small losses are not simply turned into small profits. We find the same overall pattern for the wider interval width of 0.015, but with smaller values (graph A2). Despite this similarity, the graph for interval 0.015 supports a different view: it suggests that the discontinuity declined but still remained at a high level until 2002 before it disappeared in 2003 and did not reappear afterwards. This pattern replicates the one reported by Gilliam et al. (2015).

In the reduced sample of firms with revenues of at least 2 million USD (panels B1 and B2), the pattern is less similar to the one in Gilliam et al. (2015). Based on the narrow loss interval of 0.005, $SLD$ decreases significantly, especially in the periods from 2001 to 2002 and 2010 to 2015. The decrease is less strong for the wide loss interval of 0.015, but still considerable. Given the negative $SLD$ values from 2008 onwards, the degree to which the kink has disappeared is unclear.

The reason why firms without sales revenues affect the measured discontinuity is apparent from the frequency distribution of scaled earnings shown in the right graph of Fig. 4. As expected, the distribution is almost fully positioned in the negative range. It tends to rise uniformly almost up to the zero threshold so that the smallest loss interval represents many more cases than the smallest profit interval. Therefore, including these firms mechanically reduces the ZE discontinuity in the overall sample.

For scaling with total assets, we only show results for the reduced sample of firms having sales revenues larger than 2 million USD (Fig. 3, C1 and C2). The graphs for the total sample are practically identical. The reason is that the losses of firms without sales are mostly substantial in relation to total assets so that few cases fall into the smallest loss interval. Based on the interval of 0.005 (C1), $SPD$ and $SLD$ converge until 2003. The discontinuity varies in the following years, becoming pronounced in some years (in particular 2010) and even inverse in others. The results for the interval of 0.015 (C2) are more stable. The graph suggests that the discontinuity measures followed a declining trend over the sample period and did not experience noticeable shifts.

Since we do not observe a sharp decline of the ZE discontinuity in 2002, our results are not consistent with a causal effect of SOX on the disappearance of the discontinuity (Atanasov and Black, 2016). A possible explanation for the gradual decline starting in the 1990s refers to changes in the listing requirements of the NYSE. For example, Dechow et al. (2003, p. 379) argue that prior to 1995, positive income was an important requirement of the NYSE's continued listing standards. In 1995, losses became irrelevant for continued listing as long as certain levels of revenues, market capitalization and operating cash flows were met. Since 1999, the rule is that losses do not prevent continued listing if certain (low) thresholds of market capitalization are met (currently, e.g., shareholders' equity of 6 million USD if net losses were reported in the last 5 fiscal years). Dechow et al. (2003, p. 379) state the following: "This shift away from an "income" focus has had a dramatic effect on the distribution of net income for NYSE firms". As a result, investors and analysts also may have adopted a more neutral stance towards small losses, which encouraged even more firms to report small losses as they occurred.

Table A.1 reports supplementary statistics defined in Section 2, including the standardized differences that can be used to assess the statistical significance of the kink in individual years. We also check whether changes in the sample composition that are not related to firms without sales have an effect. Our results prove to be robust in this respect as we find the same gradual decline for a balanced sample of stocks that were available in 2002.

## 4. Conclusion

The disappearance of the ZE discontinuity is an important discovery in the earnings management literature. Previous findings identify a turning point around 2002, which suggests that SOX might have been successful in decreasing earnings management activities. We argue that the dotcom boom at the turn of the millennium introduces a potential confounding effect, which (mechanically) contributes to the decline in discontinuity measures. When filtering out the dotcom effect, we note two key findings. First, it is unclear whether the ZE discontinuity has disappeared completely, because it flares up again in later years. Second, the decline is gradual over time rather than immediately after the introduction of SOX; yet such a sharp decline would be required to conclude a causal effect of SOX.

A limitation of our study is that we cannot clearly determine what caused the gradual decline of the ZE discontinuity. It is plausible that changes in the NYSE listing requirements played an important role, but more research on the driving forces of the decline would be valuable.

A general implication of our study for regulators and policy makers is that it is important to consider potential confounders in policy evaluation. In our case, without taking the dot-com effect into account, there is a risk of overestimating the disciplinary effect of SOX on earnings management. It would have been a great success of the SOX reform if it had ended the widespread practice of avoiding small losses. However, according to our analysis, the decline of this practice was not caused by SOX. Our results could therefore significantly alter the cost–benefit assessment of the SOX reform.

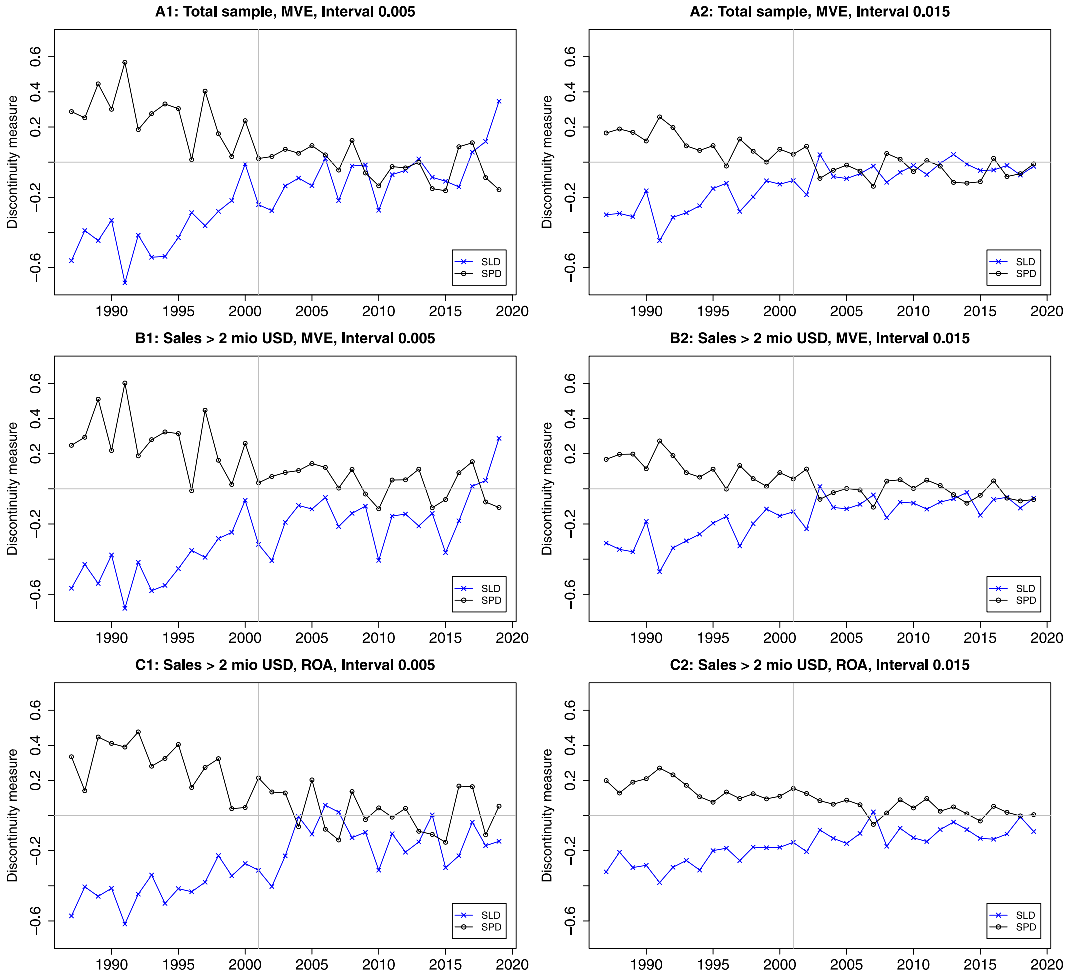


**Fig. 3. Discontinuity measure over time.** The discontinuity measure captures the share of excess observations (pos. sign) or missing observations (neg. sign) in the intervals of scaled earnings directly below and above the zero threshold. $SLD$: small loss difference, and $SPD$: small profit difference. The year 2001 is highlighted by a vertical line because it is the last year before SOX was enacted. MVE: scaling with the market value of equity, and ROA: scaling with total assets.

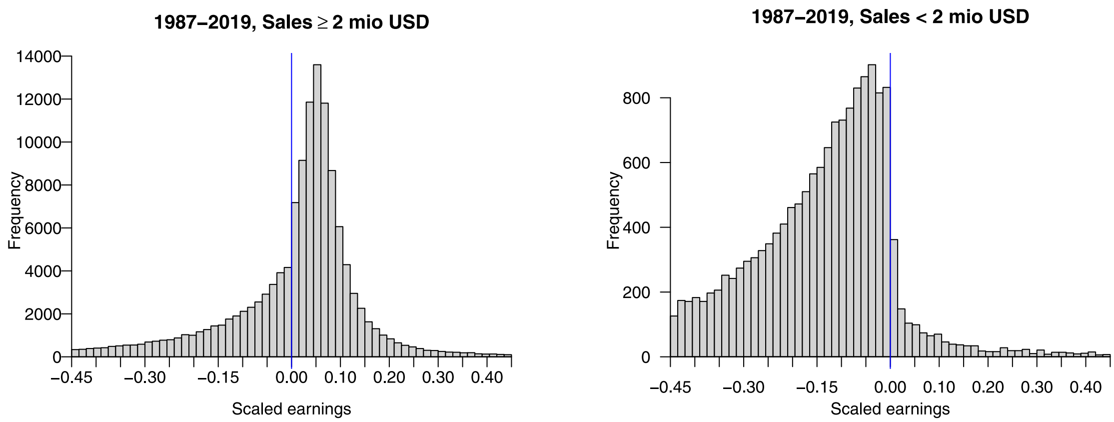


**Fig. 4. Frequency distribution of scaled earnings for firms with sales revenues of at least 2 million USD (left graph) and less than 2 million USD (right graph).** The zero threshold is highlighted by a vertical line. The interval width is 0.015. Scaling with the market value of equity.

**Table A.1**
**Discontinuity measures in the subsample of firms with sales greater than 2 million USD.** Earnings are scaled by the market value of equity. $N$ is the number of observations, $SD$ is the standardized differences t-statistic, $SLD$ is the small loss deviation, $SPD$ is the small profit deviation and $MPL$ is the modified profit-to-loss ratio. The measures are defined in Section 2.

| Year | $N$ | Interval 0.005 | | | | | Interval 0.015 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $SD_{-1}$ | $SD_1$ | $SLD$ | $SPD$ | $MPL$ | $SD_{-1}$ | $SD_1$ | $SLD$ | $SPD$ | $MPL$ |
| 1987 | 4,119 | −4.19 | 1.93 | −0.57 | 0.25 | 1.06 | −7.19 | 3.63 | −0.31 | 0.17 | 0.52 |
| 1988 | 4,223 | −2.92 | 1.79 | −0.43 | 0.29 | 0.82 | −7.94 | 4.48 | −0.34 | 0.20 | 0.60 |
| 1989 | 4,075 | −4.26 | 2.81 | −0.54 | 0.51 | 1.19 | −7.13 | 3.85 | −0.36 | 0.20 | 0.62 |
| 1990 | 4,032 | −2.59 | 2.29 | −0.38 | 0.22 | 0.67 | −3.69 | 2.36 | −0.19 | 0.11 | 0.31 |
| 1991 | 4,034 | −5.61 | 3.57 | −0.68 | 0.60 | 1.61 | −11.67 | 5.68 | −0.47 | 0.27 | 0.88 |
| 1992 | 4,144 | −2.74 | 1.08 | −0.42 | 0.19 | 0.71 | −9.38 | 5.08 | −0.34 | 0.19 | 0.58 |
| 1993 | 4,395 | −4.97 | 2.77 | −0.58 | 0.28 | 1.11 | −7.65 | 2.68 | −0.30 | 0.09 | 0.44 |
| 1994 | 4,792 | −5.16 | 3.39 | −0.55 | 0.32 | 1.08 | −6.26 | 1.24 | −0.26 | 0.07 | 0.36 |
| 1995 | 5,087 | −4.58 | 3.24 | −0.45 | 0.31 | 0.88 | −5.26 | 2.60 | −0.20 | 0.11 | 0.32 |
| 1996 | 5,562 | −2.87 | 0.39 | −0.35 | −0.01 | 0.42 | −4.30 | −0.61 | −0.16 | −0.001 | 0.17 |
| 1997 | 5,932 | −4.49 | 4.32 | −0.39 | 0.45 | 0.86 | −10.18 | 4.46 | −0.33 | 0.13 | 0.52 |
| 1998 | 5,812 | −2.85 | 1.74 | −0.28 | 0.16 | 0.48 | −6.25 | 2.38 | −0.20 | 0.06 | 0.28 |
| 1999 | 5,624 | −1.45 | 0.57 | −0.25 | 0.02 | 0.31 | −3.11 | 0 | −0.11 | 0.01 | 0.14 |
| 2000 | 5,381 | −0.70 | 2.15 | −0.07 | 0.26 | 0.30 | −4.38 | 2.77 | −0.15 | 0.09 | 0.26 |
| 2001 | 5,218 | −2.20 | 0.96 | −0.32 | 0.03 | 0.41 | −2.88 | 1.13 | −0.13 | 0.06 | 0.20 |
| 2002 | 4,921 | −3.18 | 1.04 | −0.41 | 0.07 | 0.59 | −5.73 | 2.98 | −0.23 | 0.11 | 0.37 |
| 2003 | 4,605 | −2.21 | 1.18 | −0.19 | 0.09 | 0.30 | 0.79 | −1.93 | 0.01 | −0.06 | −0.07 |
| 2004 | 4,434 | −0.76 | 1.47 | −0.09 | 0.10 | 0.20 | −2.52 | −0.68 | −0.11 | −0.02 | 0.09 |
| 2005 | 4,271 | −0.97 | 1.37 | −0.11 | 0.14 | 0.26 | −2.78 | −0.43 | −0.11 | 0.002 | 0.12 |
| 2006 | 4,133 | −0.23 | 0.55 | −0.05 | 0.12 | 0.17 | −1.91 | −0.21 | −0.09 | −0.01 | 0.09 |
| 2007 | 4,052 | −2.06 | 0.92 | −0.21 | 0.004 | 0.25 | −0.42 | −3.49 | −0.03 | −0.10 | −0.07 |
| 2008 | 3,929 | −0.96 | 1.19 | −0.14 | 0.11 | 0.25 | −3.84 | 1.80 | −0.16 | 0.04 | 0.22 |
| 2009 | 3,780 | −0.45 | −0.18 | −0.10 | −0.03 | 0.07 | −1.49 | 1.55 | −0.08 | 0.05 | 0.13 |
| 2010 | 3,615 | −3.02 | 0.20 | −0.41 | −0.11 | 0.40 | −1.78 | 0.04 | −0.08 | 0.002 | 0.09 |
| 2011 | 3,523 | −1.28 | 0.40 | −0.15 | 0.05 | 0.22 | −2.92 | 1.25 | −0.12 | 0.05 | 0.17 |
| 2012 | 3,439 | −1.07 | 0.54 | −0.14 | 0.05 | 0.21 | −1.46 | 0.49 | −0.08 | 0.02 | 0.10 |
| 2013 | 3,434 | −1.77 | 1.54 | −0.21 | 0.11 | 0.34 | −0.75 | −1.33 | −0.06 | −0.03 | 0.03 |
| 2014 | 3,440 | −0.36 | −0.50 | −0.14 | −0.11 | 0.04 | −0.59 | −2.87 | −0.02 | −0.08 | −0.06 |
| 2015 | 3,397 | −2.00 | 0.23 | −0.36 | −0.06 | 0.39 | −3.38 | −0.78 | −0.15 | −0.04 | 0.13 |
| 2016 | 3,277 | −1.01 | 1.21 | −0.18 | 0.09 | 0.29 | −1.38 | 1.00 | −0.06 | 0.05 | 0.11 |
| 2017 | 3,274 | −0.50 | 1.41 | 0.01 | 0.15 | 0.13 | −0.87 | −1.64 | −0.05 | −0.05 | −0.01 |
| 2018 | 3,529 | 1.12 | −0.27 | 0.05 | −0.07 | −0.12 | −2.61 | −2.57 | −0.11 | −0.07 | 0.04 |
| 2019 | 3,124 | 2.87 | −1.46 | 0.29 | −0.11 | −0.37 | −1.15 | −1.57 | −0.05 | −0.06 | −0.01 |

## CRediT authorship contribution statement

**Patrick Chardonnens:** Conceptualization, Methodology, Software, Writing – original draft. **Peter Fiechter:** Data curation, Methodology, Writing – review & editing. **Martin Wallmeier:** Conceptualization, Methodology, Software, Writing – original draft.


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## Appendix

See Table A.1.

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