ETLA

Working Papers | 60

24.8.2018

Missing Growth in Finland

Juho Anttila
The Research Institute of the Finnish Economy
juhojmanttila@gmail.com

Suggested citation:
Anttila, Juho (24.8.2018).
"Missing Growth in Finland".

ETLA Working Papers No 60.
http://pub.etla.fi/ETLA-Working-Papers-60.pdf

Abstract

This study investigates the extent of 'missing growth' in Finland due to upward bias in the cost-of-living measurement. This upward bias, as documented by Aghion et al. (2017), results from the quality adjustments that statistical offices use for entering and exiting products. This bias is estimated using a method by Aghion et al. (2017), which is based on establishments' entry- and exit-dynamics. The baseline result suggests an average missing growth of 0.69 percentage points over the years 2006–2013. Additionally, product- and establishment-level data are used to study the identification assumptions behind the market share method. This study's results raise some concerns regarding the validity of these assumptions.

Tiivistelmä

Puuttuva kasvu Suomessa

Tässä tutkimuksessa tarkastellaan elinkustannusten mittaamisessa esiintyvästä harhasta johtuvan ”puuttuvan kasvun” suuruutta Suomessa. Tämä harha, kuten Aghion ym. (2017) esittävät, on seurausta tilastoviranomaisten uusiin ja poistuviin tuotteisiin käyttämästä laatukorjauksesta. Harhan suuruus estimoidaan käyttämällä Aghionin ym. (2017) menetelmää, joka perustuu suomalaisten uusien ja poistuvien toimipaikkojen markkinaosuuksien kehitykseen. Benchmark-tuloksen mukaan vuosina 2006–2013 puuttuvan kasvun suuruus oli keskimäärin 0,69 prosenttiyksikköä vuodessa. Aghionin ym. (2017) tutkimuksen replikoinnin lisäksi tässä tutkimuksessa käytetään yksityiskohtaisempaa tuote-toimipaikka-aineistoa, joka mahdollistaa keskeisen markkinaosuusmenetelmän taustalla olevan oletusten tarkastelun. Tulokset osoittavat, että kyseiset oletukset ovat mahdollisesti ongelmallisia.

I am grateful to Mika Maliranta for helpful comments and suggestions regarding this paper.

Olen kiitollinen Mika Malirannalle runsaista kommenteista sekä ehdotuksista paperiin liittyen.

Key words: Inflation measurement, Creative destruction, Economic growth

Asiasanat: Inflaation mittaaminen, Luova tuho, Talouskasvu

JEL: O3, O4

1 Introduction

Statistical offices measure changes in the cost of living by tracking price changes of baskets of goods and creating price indices based on these changes. There are, nonetheless, numerous biases associated with price indices. For example, when the prices of goods included in a basket increase, consumers switch to cheaper goods, which are not necessarily included in the basket. This creates an upward bias in the cost-of-living measurement. Moreover, the quality of products tends to increase in time along with their prices (Hausman, 2003). Changes in the product quality are typically hard to measure, especially when only price data is available. Hedonic regression, a popular method, typically requires detailed data on a product's characteristics, and it is also likely to suffer from endogeneity problems (Hausman, 2003). The upward bias in inflation implies that there is 'missing growth' in the economy that is absent from the real GDP statistics.

Aghion, Bergeaud, Boppart, Klenow and Li (2017; hereinafter ABBKL), describe how variety expansion and creative destruction can lead to missing growth in the product market. When a new item enters the market, statistical offices typically resort to *imputation* to compute its price change, which is the average price change of continuing products within that product category. If the quality of the entering product is better than the average quality of the continuing products within the same category, as implied by the Schumpeterian growth theory (Aghion et al., 2014), this will bias the measured quality-adjusted inflation upwards and, hence, result in missing real growth.

ABBKL present the argument with a simple model of creative destruction and then use two methods to estimate the amount of missing growth in the United States. The first approach exploits the fact that changes in the market shares of entering and continuing products reflect the extent to which imputation based on continuing products is representative of the inflation in the whole economy. The idea is that changes in the market shares of entering products convey information about the improving quality of the products, which can then be exploited to estimate the missing growth. The second approach uses indirect inference to estimate the model's parameters and, consequently, the amount of missing growth in the economy. The various estimates of missing growth range from 0.55 (for years 1996–2005 using the market share approach) to 1.25 (1983–1993 using indirect inference) percentage points per year. In a related paper, Aghion, Bergeaud, Boppart and Bunel (2018; hereinafter ABBB) apply the market share approach to France where they document a similar magnitude of missing growth as in the US.

The contributions of this paper are twofold. First, the original study by ABBKL is replicated using Finnish data by applying the market share method to calculate total missing growth in Finland both on the economy and industry levels. Second, in order to provide a more comprehensive picture of missing growth and to assess some of the identifying assumptions needed in the market share method, the missing growth for Finnish manufacturing industries is computed using more detailed data that contains information about the individual production lines and their revenue in Finnish manufacturing establishments. This paper's estimates for missing growth using the market shares of entering and exiting establishments fall well within the range of ABBKL and ABBB, with the missing growth over the years 2006–2013 in the benchmark specification of 0.69 percentage points annually. Industry-level analysis reveals that missing growth in Finland occurs mainly in the service sector, while the figures for the manufacturing sector are fairly small and, in some cases, even negative. Finally, a comparison of the missing growth estimates from the product-level and establishment-level data indicates some caution be taken regarding the key identification assumption of the market share method, at least when applied to the industry level.

ABBKL are not the first to study biases in the cost-of-living measurement (see, for example, Lebow and Rudd (2003) and Hausman (2003) for general treatments of the various biases in inflation measurements). The upward bias associated with quality adjustments and entry-exit-dynamics has proven to be a particularly controversial topic, as the quality of products is largely unobserved, and the estimates of the bias are sizable. When making quality adjustments, statistical offices typically resort to hedonic regressions, which, as discussed, can produce misleading results.

Along with ABBKL, various other studies have proposed alternatives to hedonics to quantify products' changes in quality. The insight of linking quality growth measurements to the market shares of entrants and exiters comes from Feenstra (1994), who applies it to the US import price indices. The market share method is also used by Broda and Weinstein (2010), who compute the bias in measured inflation using barcode scanner data consisting of 700,000 different goods. The market share method used by ABBKL is basically the same as the one used in these two studies. However, in contrast to Broda and Weinstein (2010) ABBKL use the market shares of continuing establishments instead of products. The estimated bias in both cases is rather large with the annual upward bias in measured inflation being 0.74 and 0.7 in ABBKL's and Broda and Weinstein's benchmark specifications, respectively.

2 The Market Share Method

This section briefly presents ABBKL's market share method. The idea is to link the entry and exit of new establishments to growth mismeasurements. The key identifying assumption is that firms introduce new products by opening new establishments. Moreover, the number of new products introduced by a new establishment is constant across different establishments.

The method is derived from a simple Schumpeterian growth model. In the model, the final good is produced with constant-elasticity-of-substitution (CES) technology using inputs from monopolistic intermediate goods producers. The intermediate goods are, in turn, subject to innovation, which stems from three sources: (i) creative destruction, (ii) incumbent own innovation and (iii) variety expansion. By assumption, the statistical agency only observes (ii) and resorts to imputation to calculate (i) and (iii). However, if the true quality growth of products subject to (i) and (iii) is higher than the value from imputation, the demand for these products grows with respect to continuing products. Consequently, the market share of entering products with respect to continuing products then rises over time.

Following the notation by ABBKL, denote B as the first occurrence of an establishment in the data and D as the last. In the period t, the *continuers* I_t are defined as establishments that are in the data for both t and $t+1$; that is, $B \leq t$ and $D \geq t+1$. *Exiters*, denoted as X_t, are establishments that occur in the data for the last time at t; that is, $B \leq t$ and $D = t$. Finally, entrants E_t are establishments that enter the data at t, so that $B = t$ and $D \geq t$. Denote $L(t, \mathcal{M})$ as the total employment of group $\mathcal{M}$ in period t. The market share approach then estimates the missing growth by using the following equation, derived from the model[1]:

[1]For details about the derivation, see the original paper.

$$MG_{t+1} = \frac{1}{\sigma - 1}\Bigg[\log\left(\frac{L(t, I_t)}{L(t, I_t) + L(t, X_t)}\right) - \log\left(\frac{L(t+1, I_t)}{L(t+1, I_t) + L(t+1, E_{t+1})}\right)\Bigg],$$

or equivalently,

$$MG_{t+1} = \frac{1}{\sigma - 1}\Bigg[\log\left(1 - \frac{L(t, X_t)}{L(t, I_t) + L(t, X_t)}\right) - \log\left(1 - \frac{L(t+1, E_{t+1})}{L(t+1, I_t) + L(t+1, E_{t+1})}\right)\Bigg]. \tag{1}$$

The parameter σ is the elasticity of substitution of the aggregate production function (or, with an alternative interpretation, the utility function of the representative household). Therefore, conditional on knowing the value of σ, the missing growth in the economy can be straightforwardly calculated from the entrants' and exiters' market shares using (1).

Equation (1) reveals the intuition behind the market share method. The statistical office bases its quality adjustment on the continuers I_t. Whenever the market share of I_t remains stable from t to $t+1$, the inflation observed by the statistical office corresponds to the true inflation, whereas when the market shares of entrants are high, there will be more missing growth, implying that consumers are switching to higher-quality entering products.

ABBKL measure the last period of operation, D, as the last year an establishment appears in the data. ABBKL also argue that since it typically takes time for establishments to accumulate new customers and market share, and since entering establishments tend to introduce new products in their first five years of operation, mapping B simply to the first year of occurrence in the data (denoted as B^d) is likely to produce noisy estimates. Instead, they map B into $B^d + k$ and set $k = 5$ years in the baseline specification.

It is worth noting that the market share method relies on the rather strong assumption that the entry of new products can be identified by the opening of new establishments. This suggests that establishments' product innovations do not play an important role. This paper returns to this assumption later with the study of the production dynamics within establishments.

3 Data

This study uses data from the Statistics Finland business register on establishments. This data contains information on Finnish establishments, namely their revenue, employment and industry. The annual panel also includes the years 1988–2016, but due to missing establishment identifiers during the first years, the observations from 1996 onwards are used for the baseline specifications. However, the results for manufacturing industries are also calculated from the year 1988 onwards. Additionally, to complement this study's analysis, biennial data available for the manufacturing industries starting from 1976 is used.

Following ABBKL and ABBB, all agricultural establishments are removed from the panel. Also removed are establishments belonging to certain legal entities from the data, such as the state church, estates or unemployment funds. Additionally, this study omits observations where full-time equivalent (FTE) employment is missing or zero. Finally, following ABBKL cases where re-entry exists are also omitted.

Results from the Statistics Finland PRODCOM data, which contains information on Finnish manufacturing establishments and their individual production lines for the years 2004–2015, also complement this study's analysis. However, observations with either a missing product identifier or sales revenue are removed. Finally, in order to deal with noise and outliers in the data, also removed are the top and bottom 5% of the production lines, based on the price of the product each year for a given product identifier, as well as the top and bottom ones of any particular product identifier that had fewer than 20 production lines in a given year.

4 Results

Table 1

Table 2 explores the sensitivity of the results based on the choice of establishment minimum age parameter, k. As in France and the US, the extent of missing growth tends to increase as the most recently founded establishments are dropped from the sample. For $k = 0$ and $k = 5$, the missing growth in Finland is multiple times larger than in the US and France, respectively, yet this difference disappears as k increases to the benchmark case, $k = 5$.

Table 2

In Table 3, the average missing growth over the years 2002–2016 is calculated for selected two-digit industry groups, using the baseline specification of $k = 5$ and $\sigma = 4$ as well as the results from ABBKL for comparison. The pattern in two countries is highly similar with the missing growth in manufacturing being considerably lower than in service industries such as health care. The magnitude of missing growth on the sectoral level is roughly the same in two countries. Table 4 provides a similar comparison with the results of ABBB for France. In contrast to the US, the missing growth in France is smaller than in Finland in every industry considered. Otherwise, the pattern is similar, with missing growth more prevalent in service industries.

Table 3

Table 4

4.1 Missing growth in Finnish manufacturing

This study now turns its attention to a more detailed analysis of the missing growth in the Finnish manufacturing sector by estimating the missing growth for a longer period starting from the 1980s. Also, product-level data, as opposed to just establishment-level data, is used. As Table 3 shows, missing growth in manufacturing was relatively low during 2002–2016 when compared with many service industries, such as health care. Unfortunately, the extended data going back to the 1970s, as well as product-level data, are only available for the manufacturing industries. Moreover, defining and measuring products in services can be considerably harder than physical products.

First, Table 5 lists the average missing growth in Finnish manufacturing by decade using a biennial sample from 1976 to 2016.[2] The estimated missing growth from the biennial sample is extremely small, and curiously, the estimated missing growth in the 1980s is even negative. Nonetheless, there is some mild evidence of an increase in missing growth in Finnish manufacturing over time.

Table 5

One implication of the Schumpeterian growth theory is the importance of within-firm innovation in expanding product variety and quality (Aghion et al., 2014). ABBKL and ABBB account for within-firm variety expansion by assuming that new products are introduced by founding new establishments, with the number of products produced within an establishment being (roughly) constant. However, the PRODCOM data contains information on the individual production lines of Finnish manufacturing industries. Therefore, the robustness of the establishment-based missing growth estimates can

[2] Annual data for manufacturing is availably only up to the year 1988.

be assessed by calculating the missing growth using the shares of entering and exiting production lines and comparing those estimates to those using entering and exiting establishments.

Table 6 lists the average missing growth figures over the years 2009–2015 in Finnish manufacturing industries where product-level data is used instead of establishment-level data with different values of k. The final column lists the missing growth for each industry, using the establishment-level data and sales revenue shares of entrants and exiters for this calculation.

Overall, the product-level missing growth figures are fairly close to each other regardless of the value of k. As with the establishment level, increasing k seems to increase the estimated missing growth, even though this is visible only in certain industries. When compared with the missing growth figures from the establishments' sales revenue shares, the correspondence between the figures from the establishment level and product level is mixed at best. In some industries, such as metal products or furniture, other production, and maintenance, the figures from the establishment-level data fall to the same magnitude as those from the product-level data. However, for numerous other industries (for example, food, beverages and tobacco, or pressing), the estimated missing growth from the product-level data and establishment-level data have different signs.

The relatively weak relationship between the two missing growth measures is a somewhat troubling result. Figure 1 illustrates this relationship. There is a clear correlation between the two measures, yet it is not particularly high (0.21). This raises concerns about the use of establishment entry and exit to identify missing growth, even though this weak correlation can also reflect the limitations of the product-level data, such as the relatively small number of establishments in individual industries or the short time span. Indeed, when considering the manufacturing sector as a whole, the missing growth from the establishment-level data falls well within the range of the estimates for the product-level data.

Figure 1

One final striking result is that in many industries the estimated missing growth has been negative. Moreover, some of the negative estimates are very high, such as in the lumber industry (-6.71 when $k = 0$). As can be seen from (1), this can happen when the share of exiters is high with respect to entrants, indicating that exiting low-quality products are not being replaced by higher-quality entrants. The extreme values are, however, present only when low values of k are used, indicating that including relatively new production lines in the sample tends to make the estimates noisy. Overall, low or negative missing growth is not particularly surprising, as it is consistent with the hypothesis that the bulk of missing growth occurs in the service sector where the output by firms is considerably harder to measure.

Table 6

5 Discussion

The estimated missing growth rates for Finland are close to those by ABBKL and ABBB for the US and France, respectively. This offers reassurance that the method is able to produce plausible results, even though the overall credibility of this kind of method relies on structural assumptions that are hard to test directly. This study's results also indicate that the key identifying assumption of the market share method, namely that the entry and exit dynamics of new products can be proxied by the entry and exit dynamics of establishments, is potentially problematic. Nonetheless, the evidence from Finland suggests that this problem exists mainly when the sample is small, i.e. when an individual industry is studied.

References

Philippe Aghion, Ufuk Akcigit, and Peter Howitt. What do we learn from schumpeterian growth theory? In *Handbook of economic growth*, volume 2, pages 515–563. Elsevier, 2014.

Philippe Aghion, Antonin Bergeaud, Timo Boppart, Peter J Klenow, and Huiyu Li. Missing growth from creative destruction. Technical report, National Bureau of Economic Research, 2017.

Philippe Aghion, Antonin Bergeaud, Timo Boppart, and Simon Bunel. Firm dynamics and growth measurement in france. 2018.

Christian Broda and David E Weinstein. Product creation and destruction: Evidence and price implications. *American Economic Review*, 100(3):691–723, 2010.

Robert C Feenstra. New product varieties and the measurement of international prices. *The American Economic Review*, pages 157–177, 1994.

Jerry Hausman. Sources of bias and solutions to bias in the consumer price index. *Journal of Economic Perspectives*, 17(1):23–44, 2003.

David E Lebow and Jeremy B Rudd. Measurement error in the consumer price index: where do we stand? *Journal of economic literature*, 41(1): 159–201, 2003.

Tables

Table 1: Missing growth using different values for σ

Country	$\sigma = 3$	$\sigma = 4$	$\sigma = 5$
Finland	1.03	0.69	0.52
US	1.11	0.74	0.56
France	0.64	0.42	0.32

Notes: missing growth in Finland is computed by using the market share method with the parameter $k = 5$ and measuring the market shares with FTE employment. The figures for the US and France are from Aghion et al. (2017) and Aghion et al. (2018), respectively. All the figures are averages for the years 2006-2013.

Table 2: Missing growth using different values for k

Country	$k = 0$	$k = 3$	$k = 5$	$k = 7$
Finland	0.24	0.65	0.69	0.68
US	0.07		0.74	
France		0.24	0.42	0.61

Notes: missing growth in Finland is computed by using the market share method with the parameter $\sigma = 4$ and measuring the market shares with FTE employment. The figures for the US and France are from Aghion et al. (2017) and Aghion et al. (2018), respectively. All the figures are averages for the years 2006-2013.

Table 3: Missing growth in selected industries: a comparison of Finland and the US

Industry	Finland	United States
Education	0.59	0.06
Health Care	1.36	0.80
Manufacturing	0.17	0.04
Restaurants and Hotels	1.02	1.64
Retail Trade	0.80	0.91

Notes: missing growth for Finland is calculated as the average percentage points over the years 2002-2016 for each two-digit industry group individually with $k = 5$ and $\sigma = 4$. The market shares are based on FTE employment. The figures for the US are from ABBKL. The period used to calculate the missing growth in the US is 1983-2013.

Table 4: Missing growth in selected industries: a comparison of Finland and France

Industry	Finland	France
Construction	0.98	0.40
Finance	0.89	0.66
Health Care	1.19	0.18
Logistics and Communication	0.55	0.36
Manufacturing	0.19	0.04
Real Estate	2.93	0.71
Restaurants and Hotels	1.10	0.75
Retail Trade	0.87	0.78
Social and Personal Services	5.37	0.74

Notes: missing growth is calculated as the average percentage points over the years 2004-2012 for each two-digit industry group individually with $k = 5$ and $\sigma = 4$. The market shares are based on FTE employment. The figures for France are from ABBB for the same years as in Finland.

Table 5: Missing growth in manufacturing as percentage points: biennial sample

Period	Missing growth
1980-1990	-0.14
1992-2000	0.04
2002-2016	0.09

Notes: missing growth in the Finnish manufacturing industries for the years 1980-2016. The market shares are calculated from FTE employment and the parameter values $k = 4$ and $\sigma = 4$ are used.

Table 6: Product-based missing growth as percentage points in Finnish manufacturing

Industry	$k = 0$	$k = 1$	$k = 3$	$k = 5$	Establishments
Food, beverages and tobacco	-6.71	-5.31	-1.50	-0.87	0.50
Textiles and clothing	-3.15	-3.57	-2.45	-2.68	-0.48
Lumber	-8.06	-9.51	-1.41	-1.50	-0.09
Pulp and paper	-5.66	-6.00	-0.93	-0.80	-0.35
Pressing	-0.41	0.57	0.47	0.15	-0.73
Chemistry	-0.68	-0.84	-0.11	0.39	0.36
Metal refinement	-2.76	-2.38	-0.45	-0.06	0.66
Metal products	-0.28	0.04	0.23	0.69	0.75
Computers and electronic and optical devices	-0.68	-1.88	-1.47	0.04	3.33
Other electronic devices	-0.12	0.15	0.46	0.69	-0.05
Other machinery	-0.54	1.16	0.86	1.13	0.09
Vehicles	1.29	-0.83	-3.14	-3.32	0.34
Furniture, other production and maintenance	1.01	1.14	.58	0.74	0.83
Total	0.12	0.24	0.19	0.53	0.28

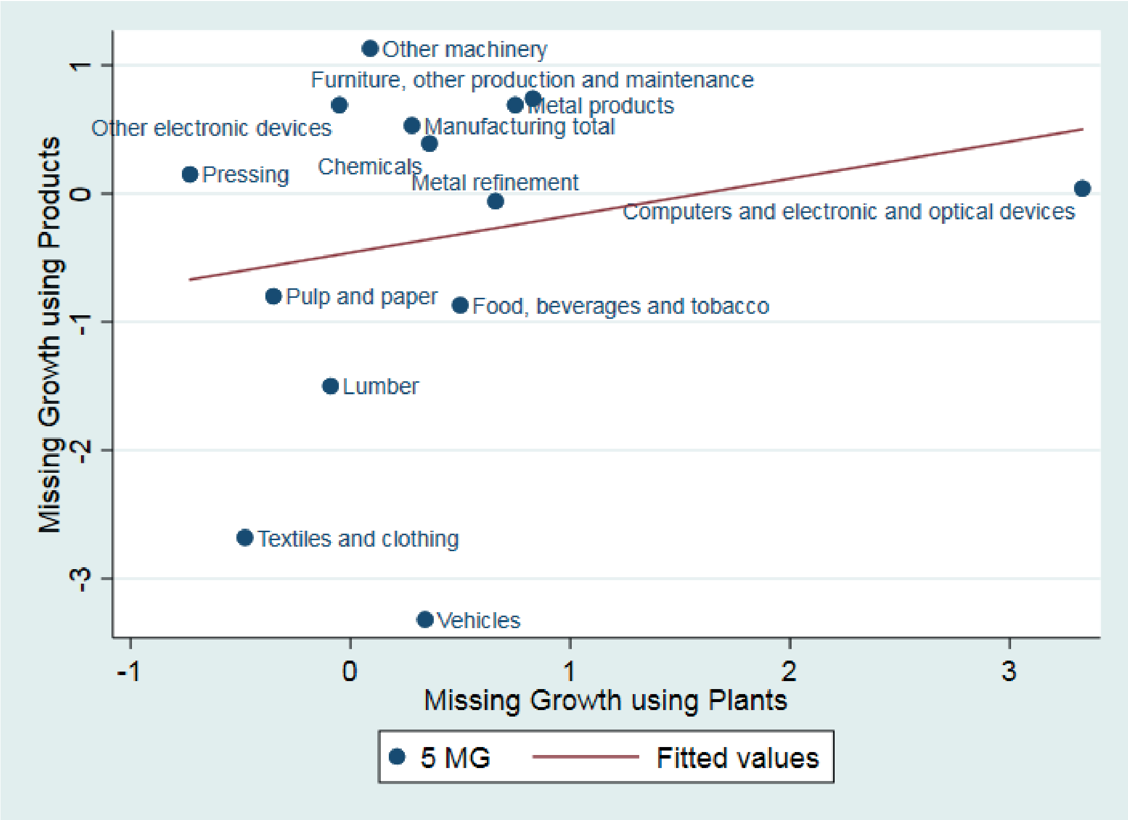
Notes: average missing growth over the years 2009-2015 in manufacturing industries where entry is defined at the production line level with different values for the minimum age parameter k, as well as the figures based on the revenue shares of entering and exiting establishments (column 5). The parameter value $\sigma = 4$ is used for all specifications. The market shares are based on the revenue shares of entering and exiting products.

Figure Captions

Figure 1. Relationship between product-based and establishment-based missing growth.

Figures

Figure 1: Relationship between product-based and establishment-based missing growth.



Notes: Both missing growth estimates are based on the revenue shares of entrants, exiters and continuers. The missing growth is calculated over the years 2009-2015 with the parameter values $\sigma = 4$ and $k = 5$.

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Elinkeinoelämän tutkimuslaitos

The Research Institute of the Finnish Economy

ISSN-L 2323-2420
ISSN 2323-2420 (print)
ISSN 2323-2439 (pdf)

Tel. +358-9-609 900
www.etla.fi
firstname.lastname@etla.fi

Arkadiankatu 23 B
FIN-00100 Helsinki