

THE EFFECTS OF INNOVATION ON EMPLOYMENT IN ESTONIAN FIRMS

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The effects of Innovation on Employment in Estonian Firms

Master's Thesis

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DECLARATION

I have written this master's thesis independently. Any ideas or data taken from other authors or other sources have been fully referenced.

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ABSTRACT

This paper investigates the relationship between different types of innovations—product, process, and environmental—and employment growth within Estonian firms. Pooled cross-sections of firm-level data from Estonian Community Innovation Survey (CIS) for the years 2008, 2014, and 2020 is combined with the Estonian Business Registry data. Using the multi-product-employment model developed by Harrison et al (2008), we employ pooled OLS and IV estimation methods to analyze the effects of these innovations on firm-level employment. Our results indicate that product innovation, as measured by sales growth due to new products, is positively associated with employment growth. The magnitude of this effect is relatively small compared to studies on firms in other countries, possibly due to redistribution among market share of existing products in Estonia. Process innovation also shows a positive but modest impact on employment growth, particularly significant in the service sector, suggesting that compensation effects from efficiency gains may offset potential displacement effects. In contrast, the relationship between environmental innovation and employment growth in Estonian firms is unclear. Regression coefficients for environmental innovation vary from negative to positive, indicating no significant and robust relationship with employment changes. This could be due to the nature of environmental innovations, which often focus on improving energy efficiency and reducing resource usage rather than expanding production capacity. These results highlight the varying impact of different types of innovations on employment. While product and process innovations are positively associated with employment, environmental innovation does not show a clear correlation with employment growth.

Keywords: Innovation, Employment, Product innovation, Process innovation, Environmental innovation

CERCS: S180 Economics, econometrics, economic theory, economic systems, economic policy

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1. INTRODUCTION

Innovation has been widely regarded as one of the key drivers of economic growth (see Grossman and Helpman, 1994; Van Reenen, 1997; Aghion & Howitt, 2009; Uppenberg, 2009; OECD 2007). In the Schumpeterian perspective, innovation is a creative destruction process implying an introduction of new technologies or products that leads to the creation of new employment opportunities or destruction of existing occupations (Schumpeter, 1939). This has made the topic of its impact on employment a long-discussed one that has been researched since the turn of 20th century (Rottmann and Ruschinski, 1998; Jaumandreu, 2003; Evangelista and Savona, 2003). With the rapid changes brought by computerization in the past decades, the growth of technological and non-technological innovations has played a key role in employment changes in many industries (Pianta and Vivarelli, 2000). However, this relationship is not straightforward. The impact of innovation on employment can vary based on the type of innovation and the specific industry it affects (see Harrison et al., 2008).

The theoretical literature generally distinguishes between two main types of technological innovations – product and process – which are expected to have contrasting employment effects. Process innovation focusing on improving efficiency and reducing costs, often results in labor savings, and potentially generates displacement effects. On the other hand, product innovation which introduces new or improved products, can create new market opportunities, and generate compensation effects (see Pfeiffer and Rennings, 2001; Dachs and Peters, 2014). Previous empirical research has shown that innovation influences firm employment levels in developed economies, though the specific mechanisms and reasons for this relationship vary considerably among studies. This might be due to differences in measures or types of innovations, datasets as well as estimation strategies (Harrison et al., 2008; Hall et al., 2008, Lachenmaier and Rottmann, 2011).

One aspect of innovation that is not as widely researched is the topic of environmental innovation. Environmental innovation largely refers to the introduction of new products, processes, or practices that aim to minimize negative impacts on the environment. Examples of these include innovation activities geared towards reduction of energy use, substitution of polluting materials and increased recycling in the production process. In the current political climate, environmental innovation (also referred to as eco-innovation or green innovation¹) has

¹ The term environmental innovation or eco-innovation is used interchangeably.

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become an important goal of the European Union's policy strategies (EU 2020). Increasing attention has been drawn to how eco-innovations introduced by firms may affect their performance and more importantly, employment level. In general, available literature on this has detected positive albeit small effects (Pfeiffer and Rennings, 2001; Rennings and Zwick, 2001; Horbach and Rennings, 2013).

There are a number of topics that bear some general relation to the effects of innovations in firms and also use similar datasets in empirical analysis. There are studies that investigate in detail the nature, drivers and determinants of innovation using different frameworks, classifications, and estimation models. Innovation surveys have also been used to study other indicators such as firm performance, total factor productivity, wages, age structure of workers as well as policy implications in the public sector. Nonetheless, the focus of this study is specifically on the employment effects of innovation, and thus, other related areas are not explored. This research will contribute to previous investigations by providing a detailed analysis on the effects of innovation and average employment growth.

The firm-level relationship between innovation and employment is an important topic of research for quite a few reasons. For instance, changes in level of employment brought about by innovative activities might affect the rate of adoption of these innovations by the employees (Harrison et al, 2008). Determining whether technological change positively or negatively affects employment, and whether its impact varies among different types of firms has therefore become relevant. A deeper insight into the dynamics of innovation and employment, possible positive and negative effects would give more understanding to industries where innovation is implemented and provide key guidance in developing effective innovation and labor policies.

Estonia presents an interesting case for examining the relationship between employment and innovation, given its ranking as one of the most innovative economies according to Global Innovation Index 2023. Maintaining a strong economic lead amongst the CEE countries in past two decades, Estonia is noted to be an innovation-driven economy with a high level of labor productivity (Trąpczyński et al.,2016). Therefore, the analysis of its employment patterns in reaction to innovation is a strong point for economic policy research.

The primary aim of this research is to examine the relationship between innovation and firm-level employment patterns in Estonia. Towards this goal, I would be studying the changes in employment levels in firms where three types of innovation activities are introduced, namely

product, process, and environmental innovation. Previous research in this field has predominantly focused on the impacts of product, process, or organizational innovation. Comparatively fewer studies have investigated these innovations collectively with environmental innovation as part of a combined framework. In addition, the paper contributes to the literature on effects of green innovation on employment.

The study uses combined data from two main datasets namely Community Innovation Survey (CIS) and Estonian Business Registry data. The main questions in the CIS questionnaire target the different types of innovation and share of company sales from introduced innovations. In addition, CIS gathers information about firms' innovation aims, the sources of information, R&D expenditure and investments as well as firm's cooperation and patenting activities. On the other hand, Business Registry data provides information on firms employment numbers, age, ownership, and turnover. By combining data from three CIS waves (2008, 2014 and 2020) with corresponding data in the Business registry, a final pooled cross-sectional data is used for empirical analysis.

The structure of the rest of the paper is outlined as follows: the next section gives an overview of existing literature on innovation activities and employment. Section 3 introduces and describes the dataset used in the study. In section 4, we explain the theoretical framework and estimation strategy employed. Section 5 presents the empirical analysis and results of estimations and finally, section 6 concludes the paper.

2. LITERATURE REVIEW

2.1. Theoretical Background

The relationship between technological change and employment is a long-debated topic and the question of how innovation affects employment has been the focus of many theoretical and empirical research studies (Hall and Kramakz, 1998; Harrison et al, 2008; Piva and Vivarelli, 2005). The focus of research has increasingly shifted from macro-level aggregated analysis to firm-level studies, which better account for the heterogeneity in firms' innovative activities and technological differences.

Theoretically, technological progress can lead to direct and indirect outcomes, each of which may be either beneficial or detrimental. Also, different economic sectors or skill groups might experience varying positive and negative impacts (Pfieffer and Rennings, 2001). For

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most firms, innovation has the potential to induce productivity gains and improve allocative efficiency, however its direct effects on labor employed still remain uncertain. A firm introducing new product lines might require more labor to meet target output hence generating compensation effects while production processes using more modern technologies might result in labor replacement. The overall effect is influenced by varying factors and subject to changes over time. Therefore, evaluating the effect of innovation on employment cannot be done solely through theoretical analysis.

This section discusses the ways in which different types of innovation might be expected to affect employment at the firm level. We refer to the Oslo Manual (2018) which is been used for CIS questionnaires for a general definition of these concepts:

- Product innovation: introduction of new or significantly improved goods and/or services which can be either new to the firm or market. The Estonian CIS collects data on two types of product innovations: goods which include tangible objects and knowledge-capturing products and services which are intangible activities that are produced and consumed simultaneously. For product innovations, there must be upgrades in significant characteristics or performance specifications either through new functions or user utility.
- Process innovation: implementation of new or significantly improved business processes for production functions that differ from what was used previously. The Estonian CIS collects data on three types of process innovations: methods of producing goods & services, logistics, delivery, or distribution methods, as well as support activities such as maintenance, accounting etc.²
- Environmental innovation: introduction of any innovative activities with environmental benefits obtained by the firm during production or obtained by end user using firm's good or service. These benefits include reduced material or water use, reduced energy use, reduced soil, water or air pollution and improved recycling of products, materials or waste.

2.2. Product and Process Innovation and employment

Firms engage in innovative activities in an effort to secure a greater market presence and obtain higher profits. The outcome of such activities on job creation or reduction within the company's operations depends on the kind of innovation being implemented. Many

² In CIS 2020, there were more than 3 process innovation type questions. All others apart from methods and logistics are grouped under "Support" for the purpose of uniformity of data.

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empirical researchers have classified technological innovation activities into two primary types: product innovation and process innovation (Vivarelli, 2015). Brynjolfsson and Milgrom (2013) pointed out in their research that some innovation types are only beneficial to the firm when they are implemented together, many empirical studies on the effects of innovation often distinguish between these two types (Harrison et al, 2005; Lachenmaier and Rottmann, 2011; Crespi et al, 2019), while others investigate the overall effect (Kancs and Siliverstovs, 2020). In this section, we focus on recent studies conducted at firm-level, particularly those that examine the impact of product and process innovation activities.

In most studies, product innovation on the firm level is associated with an increase in employment growth (Harrison et al., 2005; Hall et al., 2008). Positive direct effects describe the generation of extra employment opportunities when the market welcomes a new or improved product. Subsequently, firms with a range of products may experience indirect effects, which could be either positive or negative. If the new product partially or completely replaces the existing product, the labor demanded for producing the latter is significantly reduced. The employment impact of product innovation is positive when the new products are complements for the company's other products (Pfieffer and Rennings, 2001; Dachs and Peters, 2014). Regardless of direct or indirect, most empirical evidence leans towards a positive compensation effect on labor demand (Merikull, 2010; Bogliano and Vivarelli, 2012)

In contrast to product innovation, conclusions for process innovation effects are widely varied. Theoretical intuition for this can be described as follows: when process innovation boosts labor productivity, fewer workers are needed to maintain the same level of output, hereby creating a direct displacement effect. This lowers production costs and employment. However, reduced costs may decrease prices, potentially increasing demand for the firm's products, triggering an indirect compensation effect. Employment might then rise, depending on the degree of price reduction and how sensitive consumers are to price changes, measured by the price elasticity of demand (Benavente and Lauterbach, 2008; Lachenmaier and Rottmann, 2007). As such, there is less agreement whether the overall effect of process innovation is positive or negative. Van Reenen (1997) found no significant effect on employment levels in his study of UK manufacturing firms while Lachenmaier and Rottmann (2011) study of German counterparts found a higher positive effect for process innovation as compared to product innovation.

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Harrison et al (2008) was one of the initial studies to use the CIS data of several countries in analyzing the employment effects of innovation. Using innovation surveys from four European countries - France, Germany, Spain and UK - they developed a model that differentiated and estimated the effects of product and process innovations on employment in manufacturing and service sectors. They concluded that while productivity growth in producing old products does displace jobs, the effects of process innovations are minimal and likely offset by price decreases. More importantly, the employment gains from product innovations are strong enough to compensate for any job losses, underscoring the positive overall impact of innovation on employment.

Similar empirical studies using the CIS data include Peters (2004), Hall et al (2008), Evangelista and Vezzani (2012), Herstad and Sandven (2019). Peters (2004) study, using a revised version of Jaumandreu (2003) multi-product model to estimate the employment effects of innovation in manufacturing and service firms in Germany, evidenced a positive impact of product innovation. The results provided in Evangelista and Vezzani (2012) paper, analyzing CIS4 data across several EU countries, showed that a combination of product, process and organizational innovations had strong compensation effects in both manufacturing and service sectors. Hall et al. (2008) analyzed three waves of innovation surveys conducted by Mediocredito-Capitalia on Italian manufacturing firms and concluded that process innovation did not significantly lead to job losses.

Lachenmaier and Rottmann (2011) utilized a panel dataset of German manufacturing firms sourced from Ifo Innovation Survey to conduct their study. Their analysis differentiated between product and process innovations and applied a first-difference panel approach. Additionally, they calculated averages over four to five-year periods to assess the long-term impacts of these innovations. An identification strategy was implemented to explore how innovations influence employment growth at the firm level. Their findings indicated positive employment effects for both types of innovations, with process innovations demonstrating slightly greater impacts. Moreover, innovations that were accompanied by patent applications were found to have an additional positive effect on employment growth.

Using a different empirical methodology, Evangelista and Vezzani (2012) analyzed the employment effects of three types of innovation in a two-stage process. Leveraging CIS2004 data from six EU countries, the first stage involved estimating the effects of various innovation clusters (combinations of product, process, and organizational innovations) on sales growth to

identify "indirect" effects of innovation. Subsequently, they assessed how this innovation-driven sales growth is correlated with employment growth. Employing a 3SLS model on two simultaneous structural equations, their findings corroborated that all three types of innovation enhance sales growth, thereby improving the competitive performance of firms and facilitating the creation of additional employment opportunities.

Research from developing countries, although scanty, also provides similar evidence for product and process innovations (see Crespi et al., 2019; Baffour et al., 2018, Okumu et al., 2018; Medase and Wyrwich, 2022). Crespi et al. (2019) employed OLS and IV estimations on innovation survey data from four Latin American countries to analyze employment effects, finding that process innovation had either insignificant or negative effects on labor demand. Similarly, Baffour et al. (2018) investigated the employment effects of innovation in manufacturing and service firms in Ghana using a simple panel fixed effect model. They found a positive correlation between employment levels and product innovation, but no significant relationship with process innovation. Their research also showed that while foreign direct investment (FDI) significantly boosts employment levels, it does not have a statistically significant correlation with innovation. Additionally, Okumu et al. (2018) analyzed a cross-sectional dataset from the World Bank Enterprise Survey of manufacturing firms in Africa. Using pooled OLS estimation, they identified a positive relationship between both product and process innovation and employment growth. Collectively, these studies suggest that job losses are more common in firms that do not engage in innovation, with job creation largely driven by product innovation.

2.3. Environmental Innovation and employment

In the past two decades, there has been increasing awareness for green growth and sustainable development and as such, innovation activities geared towards environmental sustainability (eco-innovation) have been an important topic for policy makers and economists. Also, the role they play in the sustainable development of nations is acknowledged worldwide, especially within the EU context. For example, the European Commission, as part of a plan to accelerate the Europe 2020's smart, sustainable and inclusive growth goals, launched the Eco-Innovation Action Plan (EcoAP) in December 2011. The EcoAP aims to include a wider array of eco-innovative solutions, including processes, products, and services, moving the EU beyond merely green technologies.

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In recent years, firms have been encouraged to “go green” due to negative effects of pollution in the climate system. Several factors also influence firms’ decision to engage in eco-innovative activities, some firms take environmental innovation steps as a voluntary effort, or as demanded by consumer base, some in an effort to receive financial supports, and other firms do so to comply with existing or future regulations. Numerous research efforts have focused on examining the drivers, determinants and impacts of eco-innovation to improve our understanding of the knowledge area (Rennings, 2000; Horbach, 2008; Berkhout, 2011; Kemp & Oltra, 2011; Horbach, 2016; Biscione et al, 2021).

However, theoretical research and empirical analysis of employment impact of eco-innovation is still limited in existing literature, even fewer studies that investigate on firm-level data. A probable reason for this might be the fact that methods for evaluating the progress and outcomes of eco-innovations are still evolving (Melece, 2015) as well as data limitations (Elliott et al., 2021). Empirical evidence on this topic has given mixed results. Some studies show positive effect (Licht and Peters, 2013; Gagliardi et al., 2016), some others shows negative impact (Cainelli et al., 2011) and lastly those with no statistically significant effect (Rennings and Zwick, 2001).

Pfeiffer and Rennings (2001) in line with conventional innovation-employment analysis, contend that the impact of eco-innovations on employment is determined by the type of innovation activities. In their study of eco-friendly German firms, about 84 –91% of sample companies had employment-neutral effects depending on their type of innovation. Similarly, in Rennings and Zwick (2001), 88% of their sample firms were stated to have neutral effects of eco-innovation, with 18 -20% having positive effects for product eco-innovation. Overall, product and service eco-innovations had a more positive impact on employment level than process eco-innovation.

Some studies have made a distinction in motives for firms that engage in eco-innovation and found this motive to be a differential factor. Kunapatarawong and Martínez-Ros (2015) using sample dataset from PITEC to analyze the relationship between green innovation and employment in Spanish firms. They found that firms which introduced eco-innovations voluntarily had more positive effects on employment levels compared to those firms who do so to comply with environmental regulations. This provides additional support for the findings of Horbach and Rennings (2013) paper, who reported that employment does not increase when firms eco-innovate solely in response to regulations. Horbach and Rennings (2013)

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demonstrates that eco-innovations, specifically those that conserve materials and energy, lead to reduced production costs and an enhanced competitive edge, positively impacting a firm's output and demand for labor. Consequently, when firms voluntarily pursue green innovation, a positive relationship with employment is noted.

Licht and Peters (2013) carried out an extensive study of 16 European countries to examine the eco-innovation and employment relationship. Using an extended model of Harrison et al (2005) model, they decomposed the employment growth of these countries' firms between 2006-2008 into several components which allowed them to distinguish and estimate the employment impact of environmental and non-environmental product and process innovations. The findings indicate a significant positive effect of product innovation on employment growth, with product eco-innovations having less impact than non-eco innovations. For process innovation, the manufacturing sector evidenced positive effects mainly from eco-innovation while it had an insignificant impact in the service sector.

In Gagliardi et al. (2016) quantitative study of Italian manufacturing firms, they tested the effect of eco-innovation, measured by environmental-related patents, on long-run employment growth. After addressing measurement issues and endogeneity concerns, their results indicate that eco-innovations have a significantly greater positive impact on creating new jobs compared to the impact from generic innovation. This is a contrast to Cainelli et al (2011) study of Italian service firms which was done using 1993- 1998 CIS data and found a negative link between innovations driven by environmental concerns and employment growth. Cainelli concluded that the observed negative impact may stem from the unique time effects within the Italian service industry, as well as the implementation of process innovations solely aimed at enhancing efficiency without complementary product innovations, resulting in the displacement of low-skilled labor units.

As mentioned earlier, a lot of empirical studies have mainly focused on product and process innovations and not there is not as many literature on eco-innovations. A consensus found from reviewing these firm-level studies is that there are positive effects of product innovation on employment in manufacturing industries (Peters, 2005; Benavente and Lauterbach, 2008; Merikull, 2010) and positive to no significant effect of green innovation on employment (Rennings and Zwick, 2003; Horbach, 2010). Appendix A highlights the sample dataset, methodology and key results of selected papers.

3. DATA

The firm-level data to investigate the effects of innovation on employment were collected from two different sources, namely the Community Innovation Survey (CIS) and Estonian Business Registry data. This research uses three waves of Estonian CIS data CIS2008, 2014 and 2020 covering the periods 2006-2008, 2012-2014 and 2018-2020. The CIS data is combined with the Business Registry data to get pooled cross-sectional data for three separate time periods.

The CIS utilizes a standardized questionnaire to gather details on a firm's innovation activities. The Oslo manual suggests a unique definition of innovation and gives recommendations on innovation indicators as well as on the survey methodology (OECD, 2018). The surveys are usually managed by national statistical offices or research institutes under the coordination of Eurostat. The Estonian Community Innovation Survey data is collected by Statistics Estonia. Usually, the target respondents for these questionnaires are companies in the manufacturing and service sector with firm-size of at least 10 employees. The questions in the CIS questionnaire capture different types of innovations such as product, process, organizational, marketing, and environmental. It also contains questions regarding firm conditions that influence innovations, factors that hindered firms from innovating, intellectual property (IP) ownership, share of new products in company sales, R&D expenditure, foreign ownership/participation. The questions about these innovation indicators have remained largely the same over the years as well as across different countries.

The second dataset used is the Business Registry data covering the period 1995 – 2022. This data set provides the firm's field of economic activity, financial data, turnover, and demographic information such as firm age and size. This research merged the Business Registry data with CIS to maximize employment and turnover data available for analysis. In the combined dataset used for this study, we use the innovation variables from CIS data while employment and sales turnover data are gotten from the Business Registry (Table 1).

As mentioned earlier, this research has restricted its dataset to three waves with considerable time gaps between them. This is because questions about environmental innovation are found only in these select CIS waves. As such, the estimation sample is based on pooled cross sections containing sufficient information on innovation and employment.

Table 1
Description and source of variables used in dataset

Variables	Description
Community Innovation Survey Variables	
Product_innovation	Dummy that equals 1 if the firm has introduced at least one new or significantly improved good in observed period: From CIS, it is split into two questions: i. Goods: identifying if the firm has introduced at least one new/improved good. ii. Services: identifying if the firm has introduced at least one new/improved service.
Process_innovation	Dummy that equals 1 if the firm has introduced at least one new or significantly improved process in observed period: From CIS, it is split into three questions: i. Production methods: identifying if the firm has introduced at least one new/improved methods of production ii. Logistics: identifying if the firm has introduced at least one new/improved logistics/delivery iii. Support: identifying if the firm has introduced at least one new/improved support/ administrative / financial /accounting processes.
Eco_innovation	Dummy that equals 1 if the firm has introduced at least one new or significantly improved activity resulting in environmental benefits in observed period: From CIS, we use three questions in this category: i. Material: identifying if the firm has introduced at least one new/improved innovation activity that reduced material use or replaced dangerous materials ii. Energy: identifying if the firm has introduced at least one new/improved innovation activity that reduced energy use or CO2 footprint iii. Pollution: identifying if the firm has introduced at least one new/improved innovation activity that reduced air, water, soil pollution in observed period
Sales % due to new products	percentage of total sales that are due to new products from product innovation
R&D	Dummy variable that equals 1 if the firm carries out inhouse or outsourced R&D in the observed period
Voluntary	Dummy variable that equals 1 if the enterprise introduces environmental innovation voluntarily and not in response to regulations or financial support
Estonian Business Registry variables	
Number of employees	Employment level for firms in observed years of CIS data i.e 2006, 2008, 2012, 2014, 2018 & 2020
Sales	Sales figures for firms in observed years of CIS data i.e 2006, 2008, 2012, 2014, 2018 & 2020

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The data was filtered to treat outliers that could result in biased or incorrect conclusions using the Stata BACON command, removing 1% top and bottom outliers in the employment and sales figures (Weber, 2010). Also, we corrected for effects of inflation in firms' sales figures over the three observed periods by using price deflators provided by the Estonian Statistika office. Table 2 below shows the response i.e. number of observations for each CIS wave.

Table 2
The number of firms in the analysis across the years

	2008		2014		2020		
Year	Count	Share	Count	Share	Count	Share	Total
Innovative firms	1055	0.53	520	0.30	983	0.64	2558
Non innovative firms	924	0.47	1186	0.70	563	0.36	2673
Firms with product innovation	644	0.33	265	0.16	503	0.33	1412
Firms with process innovation	858	0.43	297	0.17	758	0.49	1914
Firms with environmental innovation	497	0.25	256	0.15	560	0.36	1313
Total number of firms	1979		1706		1546		5231

Source: CIS08, CIS14, CIS20 and Estonian Business Registry, own calculation

The observations are classified into subgroups based on their innovation status during the observed periods 2006-2008, 2012-2014 and 2018-2022. These subgroups are based on the firm responding positively to at least one of the questions corresponding to the type of innovation. Regarding non-innovators, these are firms that have not introduced any of the three types, hence providing negative responses to all questions. The total number of observation in dataset is 5,231 and proportion of firms with innovative activities is 53% in 2006-2008, 30% in 2012-2014 and 63% in 2018-2020.

From the table above, we see a difference in positive responses associated to the three types of innovation over the years. Looking at responses for each innovation type in the three waves, a higher percentage of firms responded "Yes" to introducing process innovation when

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compared to product and environmental innovation. Share of firms with product innovation in CIS2008 is 33%, dropping to 16% in CIS2014 and then rising back to 33% in the third CIS wave. For process innovation, share starts at 43%, dropping to 17% and picking back to 49% in CIS2020. Lastly, environmental innovation share in CIS2008 is 25%, 15% in CIS2014 and 36% in CIS2020.

For variations across the years, we see CIS2014 having the lowest number of innovative firms compared to the other two years. There is a significant drop ~50% in innovative firms across all three innovation types. Research into economic events in that period did not yield an explanation for the low number of innovative firms. Infact, key economic indicators reported by the Estonian central bank in December 2014 (Eesti Pank, 2014) show economic growth and market expansion. Therefore, we take figures as is. The descriptive statistics of innovation, employment and sales growth is presented in Table 3 below.

Table 3

Descriptive statistics of innovative and non-innovative firms

	All Firms		Innovators		Non-innovators	
	Mean	Std. dev	Mean	Std. dev	Mean	Std. dev
Share of innovative firms	0.489	0.499				
Share of firms with product innovation	0.269	0.443				
Share of firms with process innovation	0.365	0.481				
Share of firms with environmental innovation	0.251	0.432				
Employment growth (%)	18.85	10.14	22.44	10.3	15.43	9.71
Sales growth (%)	80.93	12.79	107.67	15.49	55.31	9.51
Sales growth due to new product (%)	23.52	6.45	47.0	9.21	1.04	0.38
No. of observations	5231		2558		2673	

Source: CIS08, CIS14, CIS20 and Estonian Business Registry, own calculation

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With respect to industry, the CIS data allows to classify firms into manufacturing and service industries using the Estonian Classification of Economic Activities (EMTAK) code. Manufacturing firms make up about 53-55% of observations across the dataset while service industry is about 45–47%. Divisions in manufacturing represented in the dataset include food, textiles, chemicals, plastics, electrical engineering and motor vehicles. Service divisions include wholesale, transport, ICT, construction, financial services and other business related services. The distribution of firms into EMTAK 2008 2-digit sub-class can be seen in Table 4.

Table 4
Distribution of firms across fields of activity per wave

EMTAK	2008		2014		2020		Innovators		Non-innovators	
	Count	Share	Count	Share	Count	Share	Count	Share	Count	Share
B	43	2.17	40	2.34	35	2.26	55	2.15	63	2.36
C	1054	53.23	909	53.28	779	50.39	1,393	54.46	1349	50.47
D	55	2.78	54	3.17	40	2.59	78	3.05	71	2.66
E	76	3.84	63	3.69	62	4.01	112	4.38	89	3.33
G	174	8.84	139	8.15	151	9.77	183	7.15	281	10.51
H	220	11.11	185	10.84	179	11.58	248	9.7	336	12.57
J	147	7.42	167	9.79	153	9.9	229	8.95	238	8.9
K	72	3.64	29	1.7	66	4.27	103	4.03	64	2.39
M	132	6.67	120	7.03	81	5.24	154	6.02	179	6.7
N	5	0.25					3	0.12	2	0.07
S	1	0.05							1	0.04
TOTAL	1979	100	1706	100	1546	100	2558	100	2673	100

Source: CIS08, CIS14, CIS20 and Estonian Business Registry, own calculation

4. METHODOLOGY

4.1. Model specification

This research takes the same starting point as Harrison et al (2008) multi-product model. The model was developed to distinguish different forms of innovation and estimate their effect on employment growth. Furthermore, Licht and Peters (2013) extended the model to estimate the effect of environmental innovation on employment growth. This is especially effective as both papers made use of CIS data which will also be used in this study.

In the base model, a firm f is observed at two points in time t ($= 1, 2$). At time $t=1$, the firm produces one or more products which are aggregated into one product called the “old” or “existing” product. Between $t=1$ and $t=2$, the firm can decide to produce one or more new or significantly improved product. The new product can partially or completely replace the old one if they are substitutes or enhance the demand for the old product if complementary. As a result, the firms’ output at time $t=2$ is decomposed into the output of the old product along with the potential output for the new product. The potential output for the new product is zero if the company has not invested in any form of innovation in the observed time periods.

We assume each product is produced using the identical separable technology production function, with constant returns to scale for inputs (labour L , capital K and intermediate inputs M). Also, these production functions are associated with an efficiency parameter θ , which can change with time, hence old products can become more efficient in production over time or in some cases become less efficient. The production technology for the firm can be written as³:

$$Y_{it} = \theta_{it}F(K_{it}, L_{it}, M_{it}) \quad i, t = 1, 2 \quad (1)$$

Further in the paper, Harrison et al (2008) followed by analyzing labor demand based on costs, output, and production efficiency. The cost function at time t for the firm is written as:

$$C_{(w_{1t}, w_{2t}, Y_{1t}, Y_{2t}, \theta_{1t}, \theta_{2t})} = c_{(w_{1t})} \frac{Y_{1t}}{\theta_{1t}} + c_{(w_{2t})} \frac{Y_{2t}}{\theta_{2t}} + Q \quad (2)$$

³ Firm products are indexed $i= 1,2$ for old and new products, and time $t=1,2$ for beginning and end periods respectively

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where $c_{(w)}$ is marginal cost, a function of input prices w and Q stands for fixed costs. Using Shephard's Lemma, the conditional demand for labor in production of each product is then:

$$L_{it} = c_{L(w_{it})} \frac{Y_{it}}{\theta_{it}} \quad (3)$$

where $c_{L(w_{it})}$ is derivative of $c_{(w)}$ with respect to wages. By assuming consistent costs and stable input prices i.e. the case where relative prices do not change much over time or across products, they decomposed employment growth measured into the contribution to growth from the old products and the contribution from the new products (recall labor input for new products at time $t=1$, $L_{21}=0$):

$$l = \frac{\Delta L}{L} = \frac{L_{12} - L_{11}}{L_{11}} + \frac{L_{22}}{L_{11}} \quad (4)$$

where L_{11} and L_{12} represent labor input for old product at time $t=1$ and $t=2$ respectively. Similarly, L_{21} and L_{22} represent labor input for new product at time $t=1$ and $t=2$ respectively. Based on the underlying framework, the regression equation used to estimate the effects of innovation on employment is as follows:

$$l - g_1 = \alpha_0 + \alpha_1 d + \beta g_2 + v \quad (5)$$

where l is the employment growth between the two periods, g_1 and g_2 are the growth in sales of old and new products respectively, d captures the introduction of process innovations. α_0 represents the average efficiency growth in producing the old product and v is a random error. Based on this, we see that the effect of innovation on employment depends on product innovation, process innovation and relative efficiency parameters. The term as $l - g_1$ captures a one to one relationship between employment growth and sales growth due to old product. Coefficient of sales growth of old products g_1 is restricted to one and can be subtracted from l therefore results are still interpreted in terms of employment growth.⁴

Licht and Peters (2013) extended this model further to account for environmental innovations. Considering the measurement, data and indicators used for studying eco-innovation effects, they estimated employment effects that resulted from product and process innovations with and without environmental benefits. Their equation, (6) below decomposed employment growth rate into efficiency gains through environmental and non-environmental

⁴ Refer to original paper Harrison et al (2008) and Crespi et al (2018) for more detailed explanations.

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process innovation and sales growth due to new products with and without environmental benefits.⁵

$$l - g_1 = \alpha_0 + \alpha_1 pc_{ENV} + \alpha_2 pc_{NE} + \beta_{ENV} g_{2,ENV} + \beta_{NE} g_{2,NE} + u \quad (6)$$

Just like in equation (5), l represents employment growth, process innovation is captured as pc_{ENV} and pc_{NE} while $\beta_{ENV} g_{2,ENV}$ and $\beta_{NE} g_{2,NE}$ represents output growth due to new product (indices $_{ENV}$ and $_{NE}$ represent environmental and non-environmental respectively). The dependent variable in their analysis EMP defined as $l - g_1$ captured a one to one relationship between employment growth and sales growth due to old product.

Based on this framework, this research considers a similar equation to estimate the impact of innovation on firm-level employment. We extend the original model and equation (5) to include the impact of eco innovation on employment. To this end, the reduced form estimation equation is as follows:

$$l_{ft} - g_{1ft} = \beta_0 + \beta_1 I_{(prcs)}_{ft} + \beta_2 I_{(eco)}_{ft} + \beta_3 g_{2ft} + \sigma + \tau + u \quad (7)$$

The dependent variable $l - g_1$ is the employment growth minus growth in sales of old products of firm f at time t (g_1 assumes a unitary coefficient)⁶. The term g_2 denotes sales growth due to new products and captures firm's product innovation. $I_{(prcs)}$ and $I_{(eco)}$ are indicator variables for process and environmental innovation representing the impact of a firm responding yes or no to the questions in the CIS survey that pertain to the corresponding type of innovation.⁷ σ accounts for time effects, τ for industry effects and u represents the error term.

In addition, the empirical analysis attempts to distinguish the separate effects of product and process innovations since most firms do both at same time. The effects of process innovation can be (i) improving efficiency of old products (ii) related to introduction of new products. For these two, we define a dummy variable (Process_only) that takes value of 1 if

⁵ See Licht and Peters (2013) for more in-depth classification of environmental product and process innovation variables derived from CIS (2008) data.

⁶ The variable g_1 embodies three effects – “autonomous” increase in demand, “compensation” effect from price changes due to process innovation and “substitution” effect on demand due to product innovation. These effects cannot be decomposed due to data limitation, so we take coefficient of g_1 as 1.

⁷ In the three CIS waves, environmental innovation has up to 7 questions. However, they are collapsed into 3 for this analysis.

firm has introduced process innovation but not product innovation. Process_only captures the effect of old products while effects related to new products are captured by the sales growth due to new products.

4.2. Estimation strategy

A key factor in this analysis is the issue of frequency for one of the indicator variables. Eco innovation, unlike product or process innovation, unfortunately has not received adequate coverage in the CIS surveys over the years. It was initially introduced in 2008 but questions of this nature did not reappear until CIS2014, followed by another significant gap until 2020. Consequently, we lack a sample panel dataset that includes all the necessary explanatory variables. This limitation renders estimation using Fixed Effects or Random Effects unsuitable. Therefore, equation (7) is estimated using the pooled OLS and instrumental variable IV methods. The model includes controls for both time and industry effects. Industry dummies are used in capturing average characteristics across industries that may influence employment growth, such as hourly wages or effects stemming from industry-specific changes. Similarly, year dummies are used to account for common macroeconomic shocks, as the periods in our analysis might include various phases of the business cycle.

In addition, we take into account possible endogeneity which may occur due to measurement issues or omitted variable bias. As such, we solve for this using instrumental variable estimation. We use variables that are correlated with the success of the innovations but do not necessarily imply any effect in employment. Like in Licht and Peters (2013) and Dachs and Peters (2014), we use two dummy variables as instruments: R&D and Voluntary introduction of environmental innovation⁸. R&D is a dummy variable that takes the value of 1 if firm answers yes to either carrying out inhouse R&D or outsourced R&D in the observed period. Voluntary is also a dummy variable that equals 1 if the enterprise introduces environmental innovation voluntarily and not in response to regulations or financial support. Decisions regarding R&D investments and voluntary reasons for environmental innovation are made prior to innovation decisions, influencing the firm's likelihood of innovating but not directly affecting employment growth.

⁸ Voluntary refers to one of the motives for introducing environmental innovation as in CIS. Other motives include financial support/grant, existing/future regulations, environmental taxes, consumer demand etc.

5. RESULTS

In this section, we present and discuss the results from our empirical analysis. Table 5 displays the outcomes of estimating equation (7) using the OLS method. Here, we regress employment growth on process_only, eco_inno and sales growth due to new products with year and industry dummies. Robust standard errors are reported in parentheses below the coefficients, to adjust for potential heteroscedasticity.

A general overview of estimations in columns (1) to (3) reveals mostly positive coefficients, indicating a positive linear relationship with employment growth. The sales growth variable is consistently positive and statistically significant across all specifications.

Table 5
Relationship between innovation types and employment growth; using OLS method

VARIABLES	(1) emp_growth	(2) emp_growth	(3) emp_growth
Process_only	0.073** (0.032)		0.070*** (0.028)
Eco_inno	-0.077 (0.038)	0.0264 (0.033)	
Sales_growth due to new products	0.171** (0.009)	0.173** (0.009)	0.171** (0.009)
Constant	0.046 (0.04)	0.068 (0.046)	0.045 (0.045)
Time dummies	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes
Observations	5,122	5,122	5,122
R-squared	0.131	0.137	0.130

Robust standard errors in parentheses

***p<0.01, **p<0.05, *p<0.1

Source: CIS08, CIS14, CIS20 and Estonian Business Registry, own calculation

Looking at each column presented in table (5), the first column presents the regression for all three innovation variables included, columns (2) and (3) showing linkage of eco and

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process innovations separately. Across all three, we see product innovation which is represented with sales growth due new products has positive and stable coefficient at 0.171 and is statistically significant at 5% level. The coefficients being less than one in all specifications indicate that successful product innovation is positively associated with employment growth, but the relationship is less than proportional. Similarly, process innovation with significance at 1% and 5% levels, corresponds to a 7% increase in employment growth. This means that companies introducing only process innovation see little effects in employment. Lastly, results show that eco innovation does not have any statistical significant association with employment growth.

As previously mentioned, we also employ the Instrumental Variables (IV) method to address potential endogeneity issues. Table 6 presents the results of two-stage least squares (2SLS) estimation method, using R&D dummy and Voluntary dummy as instruments for sales growth due to new products and eco-innovation respectively. The validity of our instruments was confirmed using the Wu-Hausman test and Sargan's test of over-identifying restrictions.

Table 6
Relationship between innovation types and employment growth; using IV method

VARIABLES	(OLS) emp_growth	(IV) emp_growth
Process_only	0.073** (0.032)	0.120* (0.047)
Eco_inno	-0.077 (0.038)	-0.053 (0.065)
Sales_growth due to new products	0.171* (0.009)	0.248** (0.020)
Constant	0.046 (0.04)	0.056 (0.06)
Time dummies	Yes	Yes
Industry dummies	Yes	Yes
Observations	5,122	5,122
R-squared	0.131	0.158
First stage F- statistic		23.57

Robust standard errors in parentheses

***p<0.01, **p<0.05, *p<0.1

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From the above table, we can compare estimates from OLS regressions with IV regression and we see that IV estimates are larger. Process innovation is statistically significant at 10% level and corresponds to 12% increase in employment growth. Both OLS and IV estimates for eco innovation are negative and not statistically significant, again indicating no significant impact of eco-innovation on employment growth. Lastly, IV estimate for sales growth of new products is larger and more significant, suggesting a stronger positive impact of product innovation on employment growth. The first-stage F-statistic for the IV regression is 23.57, which is above the threshold of 10, indicating that the instruments are valid and relevant. Overall, the IV estimates are reliable and not biased.

Our results indicate that firm-level employment growth is more strongly associated with product innovation than process innovation, consistent with Harrison et al. (2008). However, the magnitude of this effect is lower compared to other studies that utilized similar frameworks, such as Hall et al. (2008) for Italy, Crespi et al. (2019) for Latin America, and Benavente and Lauterbach (2008) for Chile. When compared to Meriküll (2010) paper that also analyzed Estonian data but employed the Arellano and Bond GMM-SYS method, our findings show a larger effect of innovation on employment. We can attribute this difference to the three-year lagged innovation variable used in their analysis, as their paper also suggests that the overall effects are expected to be larger. Looking at a broader picture, both studies agree that innovation positively impacts employment growth, and that the statistical significance diminishes when disaggregated into product and process innovation. Empirical evidence thus supports the theory that while innovation generally supports employment growth, the specific type of innovation and the empirical methods used influence the observed strength of this relationship.

Now, we proceed further to compare the innovation effects between the two sectors – manufacturing and service. Here, we also use IV estimation to regress equation (7), and results are shown in table 7 below. Starting with process innovation, it is positively correlated with employment growth in the two industries with stronger effects and statistical significance in service industry. Product innovation consistently impacts employment growth positively with unsurprising higher coefficient in manufacturing than services. In contrast, eco innovation does not have any statistically significant association with employment in manufacturing and service firms.

Table 7

Relationship between innovation types and employment growth; using IV method (comparison between sectors)

VARIABLES	Manufacturing emp_growth	Service emp_growth
Process_only	0.056 (0.013)	0.104* (0.038)
Eco_inno	0.0138 (0.113)	-0.130 (0.170)
Sales_growth due to new products	0.156** (0.014)	0.107** (0.016)
Constant	0.026* (0.019)	0.173 (0.027)
Time dummies	Yes	Yes
Industry dummies	Yes	Yes
Observations	2807	2315
R-squared	0.103	0.092
First stage statistic	80.13	148.14

Robust standard errors in parentheses

***p<0.01, **p<0.05, *p<0.1

Source: CIS08, CIS14, CIS20 and Estonian Business Registry, own calculation

Our findings on environmental innovation are not entirely inconsistent with existing literature. Litch and Peters (2014) categorized environmental innovations into product and process types, with results showing contrasting employment effects. Environmental product innovation had significant and positive effect on employment while environmental process had negative coefficients that were not statistically significant. Similarly, regressions for manufacturing and service firms showed mixed results at country level. We can also draw comparisons with Horbach and Rennings (2013) results in which eco innovations related to material use and energy savings were found to be positively correlated to employment while eco innovation related to air, water and soil pollution had negative effect on employment.

6. CONCLUSION

In this research, we have used firm-level data to estimate the relationship between product, process and environmental innovations and employment levels in Estonia. Using data from Estonian CIS (CIS2008, CIS2014 and CIS2020) merged with the Business registry data, this paper contributes to the existing literature by extending the research on innovation and employment nexus in Estonia to include impacts that might be associated with environmental innovation.

Interpreting the results from all regression specifications, we do see some innovation effects that are in line with previous literature. In many empirical studies, product innovation has been positively correlated with employment growth with high statistical significance. Our results indicate that product innovation, measured by the growth of sales from new products, positively impacts employment growth in Estonian firms. Consistent with the findings of Evangelista and Vezzani (2012), this suggests an indirect effect of innovation that enhances firms' competitive performance and results in the creation of new jobs. However, since the effects are relatively small in magnitude, it might be that introducing new products reduces the market share of existing products and thus the overall demand for firm's products (and consequently labor input) may remain stable or change only slightly.

Looking at results for process innovation, we observe statistically significant and positive association with employment growth with higher effects in service industry. This shows that process innovation does not lead to displacement effects as expected from a theoretical point of view. Instead, in line with Harrison et al (2008) conclusion, it would seem that compensation effects from process innovation do outweigh any displacement effects that might have resulted from unit cost reductions. Peters (2004) also concluded that efficiency gains from process innovation leading to price reduction can induce higher sales thereby increasing capacity for employment growth.

Finally, we observe that eco-innovation has no statistically significant effect on employment growth, with coefficients ranging from mostly negative to positive. Empirical results from Cainelli et al. (2011) showed a negative relationship between environmental innovation and employment growth while Litch and Peters (2014) reported a positive relationship between environmental product innovation and employment growth. Our results, however, do not provide conclusive evidence on this relationship.

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This study has some limitations which could be improved on for future research. First, there are potentially significant factors influencing firms' innovative activities and employment levels such as corporate strategy, innovation goals or management practices that remain unaccounted for due to data limitations. Additionally, the frequency of environmental innovation related questions in the CIS over the years is quite lacking and does not allow for in-depth analysis like many research have done for product or process innovations. Resolving the limitations from this dataset would allow future research to arrive at stronger conclusions towards these three innovation types. Future research could be done using this framework to analyse effects from organizational and marketing innovations as well as estimate the effects of environmental innovation in other similar CEE countries.

From a policy perspective, this research offers critical analysis on the effects of innovative activities on employment growth in Estonia. This paper gives a clearer understanding of the relationship between innovation and employment at the firm level, as well as to provide insights into policy discussions such as how the innovativeness of Estonian firms impacts economic performance and employment.

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APPENDIX A: Summary Table of Literature Review

Table A.1: Product and Process Innovation on Employment

Author and Year	Independent Variables	Sample Dataset	Methodology	Results
Harrison et al. (2005)	Sales, process and product innovations, R&D investments, cooperation, and patenting activities	CIS3 data for France, Germany, Spain, and the UK. Years 1998 -2000	Theoretical multi-product framework with instrumental variable estimation	Positive effect of product innovation, compensation effects outweigh displacement effects of process innovation
Peters (2004)	Sales growth due to new products, market novelties, firm novelties, Type and size of firm, Industry dummies, Investment	German CIS3 data for manufacturing and service firms. Years 1998 -2000	Revised multi-product framework with instrumental variable estimation	Positive effect of product innovation, negative employment effect of process innovation in manufacturing firms
Piva and Vivarelli (2005)	Innovative investments, Sales, Wage	Longitudinal dataset of 575 Italian manufacturing firms from surveys conducted by Medio Crédito Centrale (MCC). Year 1992-1997	Arellano and Bond (1991) and Blundell and Bond (1998) methodology using GMM-SYS estimation method	Significant, albeit small, positive relationship
Merikull (2010)	Innovation (R&D) activity	Micro panel data of 1122 firms from Estonian CIS data merged with commercial register. Year 1994 - 2004	Arellano and Bond (1991) dynamic panel data with GMM estimation method	Statistically significant positive effect of innovation on employment

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Author and Year	Independent Variables	Sample Dataset	Methodology	Results
Evangelista and Vezzani (2012)	Growth rate of sales and number of employees, turnover values at current prices	CIS4 firm-level data for selected EU countries. Years 2000–2002	Three-stage least squares (3SLS) model	Positive effect of product innovation on employment
Crespi et al (2019)	Employment growth rate of skilled and unskilled labor	Microdata from Innovation surveys of Argentina, Chile, Costa-Rica and Uruguay. Years 1995 - 2012	Multiproduct model using instrumental variable estimation	Product innovation has more positive association with employment growth in manufacturing firms

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Table A.2: Environmental Innovation on Employment

Author and Year	Independent Variables	Sample Dataset	Methodology	Results
Pfeiffer and Rennings (2001)	Current level of technology, type of innovation, sector, competition intensity, skill structure of work	Case studies based on semi-structured interviews with German companies Year 1996	Interview Panel data	Positive effects of product innovation on employment
Rennings and Zwick (2003)	Environmental-Factors, Market-Share, Cost-Reduction, Green innovation (product, service, recycling, end-of-pipe)	Survey of 1600 firms in five EU countries. Year 2000	Multinomial Logit and Multinomial Probit Models	Green innovation does not have effects on employment
Horbach (2010)	Demand level, Capacity level, green innovation, environmental organization, Subsidies, Investments in R&D, Environmental fields offered by the firm	Panel data of German firms. Years 2004 - 2005	Bivariate probit model	Positive effect of green innovations on employment
Cainelli et al. (2011)	Environmental innovation strategies, firm size, Sector and Geographic dummies, R&D expenditures, Factors hampering innovation, Market responsiveness factors	773 Italian service firms with 20 or more employees. Years 1995–1998	Gibrat-like empirical model	Negative link between environmental motivations and growth in employment

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Author and Year	Independent Variables	Sample Dataset	Methodology	Results
Licht and Peters (2013)	R&D investments, Environmental processes and product innovation, Ownership, Sales growth	CIS Survey for 16 EU countries Years 2006- 2008	Instrumental variable estimation	Positive effect of product innovation on employment
Gagliardi et al. (2016)	Number of environment related patents	Sample of 4507 Italian manufacturing firms with patent. Years 2001–2008	Linear model with endogeneity control	Positive impact of green innovation on employment

APPENDIX B: OLS Regression**Table B.1**

*Relationship between innovation types and employment growth; using OLS method
(comparison between sectors)*

VARIABLES	manufacturing	service
	emp_growth	emp_growth
Process_only	0.082** (0.039)	0.065 (0.051)
Eco_inno	-0.021 (0.032)	0.0153 (0.076)
Sales_growth due to new products	0.032*** (0.003)	0.007 (0.004)
Constant	0.031 (0.04)	0.154*** (0.05)
Time dummies	Yes	Yes
Industry dummies	Yes	Yes
Observations	2807	2315
R-squared	0.072	0.101

Robust standard errors in parentheses

***p<0.01, **p<0.05, *p<0.1

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Table B.2

*Relationship between innovation types and employment growth; using OLS method
(comparison between years)*

VARIABLES	(2008)	(2014)	(2020)
	emp_growth	emp_growth	emp_growth
Process_only	0.133** (0.058)	-0.031 (0.072)	0.076* (0.041)
Eco_inno	-0.0837 (0.063)	0.111 (0.100)	-0.039 (0.048)
Sales_growth due to new products	0.057** (0.009)	0.438 (0.343)	0.089*** (0.021)
Constant	0.055 (0.09)	0.051 (0.05)	0.077 (0.04)
Industry dummies	Yes	Yes	Yes
Observations	1959	1644	1519
R-squared	0.15	0.106	0.141

Robust standard errors in parentheses

***p<0.01, **p<0.05, *p<0.1

APPENDIX C: Other Descriptives

Table C.1

Industry Classification according to EMTAK 2-digit

Industry	Total		Innovators		Non-innovators	
	Count	Share	Count	Share (%)	Count	Share (%)
Mining	118	2.26	55	47	63	115
Food	321	6.14	211	66	110	52
Textiles	379	7.25	127	34	252	198
Wood	460	8.79	258	56	202	78
Chemicals	83	1.59	69	83	14	20
Plastics	173	3.31	80	46	93	116
Metals	404	7.72	200	50	204	102
Machinery_vehicles	273	5.22	146	53	127	87
Electronics	211	4.03	122	58	89	73
Other manufacturing	439	8.39	180	41	259	144
Utility_gas	149	2.85	78	52	71	91
Water_waste management	201	3.84	112	56	89	79
Media_publishing	159	3.04	63	40	96	152
Telecomms	372	7.11	190	51	182	96
Transport	589	11.26	251	43	338	135
Wholesale trade	464	8.87	183	39	281	154
Financial services	167	3.19	103	62	64	62
Technical/Scientific R&D	269	5.14	130	48	139	107
	5231		2558		2673	

Table C.2

Correlation Table of Key Regression Variables

	Employment growth	Product innovation	Process innovation	Environmental innovation
Employment growth	1			
Product innovation	0.044	1		
Process innovation	0.0275	0.3627	1	
Environmental innovation	-0.0069	0.3502	0.4519	1

Resümee

INNOVATSIOONI MÕJU TÖÖHÕIVELE EESTI ETTEVÕTETES

Magistritöö uurib erinevat tüüpi innovatsioonide — toote-, protsessi- ja keskkonnainnovatsiooni — seost tööhõive kasvuga Eesti ettevõtetes. Euroopa Liidu innovatsiooniuringu (*Community Innovation Survey, CIS*) 2008, 2014 ja 2020. aasta ettevõtte tasandi andmeid on sellel eesmärgil kombineeritud Eesti äriregistri andmetega. Kasutades Harrison et al. (2008) väljatöötatud mitme toote ja tööhõive mudelit, rakendatakse töös tavaliste vähimruutude ja instrumentmuutujate hindamismeetodeid, analüüsiks mainitud kolme liiki uuendustegevuse mõju ettevõtte tasandi tööhõivele. Analüüsi tulemused näitavad, et tooteinnovatsioon, mida mõõdetakse uute toodete müügi kasvuga, on positiivselt seotud tööhõive kasvuga. Siiski on vastava seose suurus suhteliselt väike võrreldes teiste riikide ettevõtte-taseme uuringutega, mis võib tuleneda uuritud Eesti ettevõtetes olemasolevate toodete turuosade ümberjaotamisest. Protsessiinnovatsioon näitab samuti positiivset, kuid tagasihoidlikku seost tööhõive kasvuga. See mõju on eriti märkimisväärne teenindussektoris, mis viitab sellele, et protsessiinnovatsiooniga kaasnevast efektiivsuse tõusust tulenevad kompenseerivad mõjud võivad vähendada võimalikke töökohtade kaotusi. Erinevalt toote- ja protsessiinnovatsioonidest on keskkonnainnovatsiooni ja tööhõive kasvu vaheline seos Eesti ettevõtetes ebaselge. Keskkonnainnovatsiooni regressioonikordajad varieeruvad negatiivse ja positiivse vahel, s.t. olulist ja robustset seost tööhõive muutusega ei õnnestunud tuvastada. Tõenäoliseks põhjuseks võib olla keskkonnainnovatsioonide olemus, mis keskendub sageli energiatõhususe parandamisele ja ressursikasutuse vähendamisele, mitte tootmisvõimsuse laiendamisele. Need tulemused toovad esile erinevat tüüpi innovatsioonide erineva mõju tööhõivele. Kuigi toote- ja protsessiinnovatsioonid on positiivselt seotud tööhõivega, ei näita keskkonnainnovatsioon selget korrelatsiooni tööhõive kasvuga.

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