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What determines the capital structure of farms? Empirical evidence from Poland

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ABSTRACT

The purpose of this paper is to analyse capital structure and its dynamics for farms in Poland, a leading European Union producer. The theoretical framework is based on the trade-off and pecking order theories of capital structure. We use data from the Farm Accountancy Data Network (FADN), which is representative of Polish professional farms during the period 2009–2018. We adopt a dynamic partial adjustment model using the generalized method of moments in order to explain the financing of farms through debt. The results show that Polish farms exhibit low target levels of debt, which they adjust dynamically, thus partially validating the trade-off theory. While size and growth opportunities positively influence the indebtedness of farms, profitability and land have the opposite effect. Polish farmers therefore use available internal funds, especially retained earnings, as a substitute for debt, in line with the pecking order theory.

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1. Introduction

The European agricultural sector, with more than 10 million full-time employees, creates an estimated €432 billion per year in total added value (Eurostat, 2019). As farm development requires innovation and investment, the financing of activities is a crucial issue for boosting growth, jobs and the overall development of rural areas (Turvey, 2017). Despite the subsidies provided by the Common Agricultural Policy (CAP), access to funding is one of the main obstacles to sustainable development of agricultural businesses in all European countries (Tropea & De Cavalho, 2016). The issue of limited access to credit has been considered in the literature as an important factor that can inhibit farm development, especially in Eastern European countries (Latruffe, 2005; Petrick, 2004a, 2004b; Petrick & Latruffe, 2006). A report published by fi-compass (2020) estimates the financing gap for agriculture in the EU to be between €19.8 billion and €46.6 billion.

The global macroeconomic situation during the last decade has made it even more necessary to strengthen and secure the financing capacities of agricultural businesses.

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According to Petrick and Kloss (2013), the credit crunch following the 2007–2008 financial crisis and the instability of agricultural markets (in terms of prices and/or legislation) have led to a strong decline in average farm income. The planned reductions to the European public budget for agricultural and rural policies contained within the Common Agricultural Policy (CAP) 2021–2027 may also have a negative impact on farm revenue. Given the significant relationship between capital structure and firm competitiveness (Myers, 1984), an in-depth analysis of how financing decisions are (or should be) made appears to be more relevant than ever for European farms.

Compared with large corporate firms, which have direct access to capital markets and exhibit a sophisticated capital structure, most farms have a relatively limited number of accessible financial resources, which may be summarized as internal funds and short- and long-term debt. For farms, as for all businesses, the design and optimization of capital structure play a central role in their financial management. Most of the theoretical framework concerning the capital structure of firms is based on the seminal work of Modigliani and Miller (1958), which links the capital structure of a company to its market value. Following on from this article, many scholars have demonstrated that having a choice of available financial resources is essential for optimizing firm value, giving rise to different theories of optimal capital structure. Among these, the trade-off theory (Myers, 1984) and the pecking order theory (Myers & Majluf, 1984) are probably the most well-known.

Most empirical tests of these theories have been conducted on large companies, on mature markets and using secondary data (Kumar et al., 2017). By contrast, in the agricultural sector, few studies have investigated the financial structure and policy of farms. Most empirical studies in this area have concerned the US agricultural market (Barry et al., 2000; Katchova, 2005; Zhao et al., 2008), while some notable exceptions have examined Dutch, Irish and Swiss farms (Aderajew et al., 2019; Schorr & Lips, 2019; Tian, 2013; Wu et al., 2014). Although the issue of access to credit has been tackled in some studies (Petrick, 2004a, 2004b; Petrick & Latruffe, 2006), to the best of our knowledge, no study on capital structure has previously considered Eastern European countries.

This paper aims to fill the gap and provide further evidence of the validation of the theoretical framework of capital structure – trade-off and pecking order theories – by considering Poland, a former communist country in Eastern Europe. Petrick and Weingarten (2004) convincingly state that 'the group of countries summarised as "Central and Eastern European countries" is quite heterogeneous both in terms of national income levels and progress in the transition to a market economy'. Poland may simultaneously be considered as a typical and a unique example of Eastern European agricultural systems. On the one hand, the agricultural sector has benefitted enormously from steady growth based on substantial investments that have enabled it to provide food at affordable prices. On the other hand, while collective farming was historically the norm in all Eastern European communist countries, in Poland, private farming was officially recognized as a specific element of the 'Polish road to socialism' from the late 1950s (Turnock, 1996). Private ownership of land prevailed and a certain proportion of the land left by the socialized entities was transferred to family farms. Thus, quasi-peasant farms remain as a product of post-communist transformation, which is somewhat unusual among post-communist countries (Sadowski et al., 2015). As a legacy of this, Polish farms are among the least indebted in the EU (European Commission, 2018).

Poland is a relatively important European agricultural producer, accounting for 8% of EU farmland and 6% of EU agricultural output. Its agriculture is characterized by the predominance of small and medium (rarely large) farms. Production is diversified with an emphasis on field crops and livestock, such that the country's agriculture may be considered as representative of Eastern Europe (Eurostat, 2019). As Poland benefits from the CAP, the effects of subsidies on capital structure need to be considered explicitly in order to determine whether or not farms use them as a substitute for indebtedness. Our empirical findings may also bring added value from the perspective of policymakers given the growing interest in repayable financial instruments for boosting significant green investment in the agricultural sector (fi-compass, 2020).

Our empirical analysis is based on the database of the Farm Accountancy Data Network (FADN) for the period 2009–2018. FADN data are representative of Polish professional farms, especially in terms of productive orientation. Moreover, this database includes relevant accounting and financial statements (cash flows, balance sheets and income statements) as well as information on European subsidies. It allows us to perform a complete study on the different sources of farm financing, both internal and external. In order to estimate the influence of key factors on indebtedness, we use a dynamic partial adjustment model in line with the theoretical framework. Estimates are based on the generalized method of moments (GMM), which is suitable for samples with a small number of time periods and a large number of observations. Endogeneity issues are addressed through using lagged variables as instruments, while time- and farm-invariant parameters are removed. Finally, robustness tests are performed on subsamples.

The remainder of this article is organized as follows. The second section is devoted to an overview of the existing literature on the indebtedness of farms and other businesses. The third section focuses on the empirical framework, including descriptions of the Polish context, the database and the econometric modelling. The fourth section displays, analyses and discusses the results of the econometric model, while the fifth section concludes the study.

2. Theoretical background on the capital structure of farms

This section presents the main results of previous empirical studies testing these theories in the agricultural sector. The two most well-known theories of capital structure – trade-off theory (Miller, 1977; Myers, 1984) and pecking order theory (Myers & Majluf, 1984) – are summarized and a set of research hypotheses is presented.

2.1. Empirical studies on the capital structure of farms

The first economic analysis on the use of debt by farms dates back to the 1940s, following the Great Depression (Musser et al., 1977). Historically, farms have been using debt to finance capital investments and their working capital requirements for centuries (Bogue, 1976). Due to the leverage effect of debt, farms benefit from increased profitability, productivity and growth. By contrast, the literature has shown that restricted access to credit penalises the productivity and overall performance of farms, especially in Poland and other Eastern European countries (Ciaian et al., 2012; Latruffe, 2005; Petrick, 2004a, 2004b).

Empirical studies in agricultural finance have usually focused on macroeconomic factors that affect debt levels, such as the tax rate, GDP and inflation (Aderajew et al., 2019; Ahrendsen et al., 1994; Barry et al., 2000; Collins, 1985; Featherstone et al., 2005). Wu et al. (2014) propose a unified theoretical framework that explains farm capital structure choice, focusing on utility maximization models (Collins, 1985). Their general approach enables them to consider several hypotheses but they do not refer explicitly to those connected to the usual theoretical frameworks related to capital structure. However, their empirical test shows the same relationship between debt levels and other factors previously considered in the literature.

To our knowledge, few studies have addressed the problem of farm indebtedness by considering capital structure theories. Barry et al. (2000), Katchova (2005) and Zhao et al. (2008) examine the impact of various individual, structural and financial variables on capital structure choice in the US, testing various theories (trade-off, pecking order and signalling) with mixed results. Howley and Dillon (2012) perform a similar analysis in Ireland, while Tian (2013) and Aderajew et al. (2019) investigate the capital structure of Dutch farms. Schorr and Lips (2019) consider Swiss farm capital structure with respect to performance indicators such as economic value added (EVA). These studies consider individual farm data and generally focus on only one country or one sector at a time. Generally speaking, they show that farms appear to have debt targets, which they partially adjust from time to time, in line with the dynamic version of trade-off theory. Some studies also emphasize that pecking order theory is relevant for farms that prefer internal over external funds.

2.2. The trade-off theory of capital structure

In trade-off theory, the objective of owners and managers is to optimize the indebtedness of the firm in order to maximize its value. This maximization is obtained by considering the trade-off between the costs and benefits of borrowing (Myers, 1984). The interest tax shield is balanced with the direct (repayment of the principal and interest) and indirect (monitoring and contracting, legal and administrative bankruptcy) costs of debt and with moral hazard. In a static framework, the optimal debt ratio mainly depends on the likelihood of bankruptcy, which is influenced by several accounting and economic variables described below.

Large firms, which have greater diversification of activities and less volatile profits, have a lower likelihood of bankruptcy (Smith & Stulz, 1985; Titman & Wessels, 1988). When bankruptcy does occur, tangible assets may be used as collateral, indicating a positive relationship between asset tangibility and indebtedness (Michaelas et al., 1999). This hypothesis could be very relevant for farms as their assets (e.g. land, equipment) are almost all tangible. In the same spirit, asset liquidity is of great importance, especially for small- and medium-sized companies. Asset liquidity may be positively associated with debt because a high liquidity ratio demonstrates the ability of firms to meet their short-term liabilities (Lipson & Mortal, 2009).

The most profitable firms have a greater capacity for indebtedness because recurrent cash flows indicate a smaller likelihood of bankruptcy. Subsidies, such as CAP payments, contribute to farm profitability and stability (Latruffe et al., 2010) and a reduction in risk aversion (Bhaskar & Beghin, 2009), thus favouring indebtedness (Ciaian & Pokrivcak, 2011).

Conversely, firms naturally face uncertain future cash flow and profitability. For instance, in agriculture, risk comes from various factors, such as the weather and volatile input and output prices. As a result, access to credit may be reduced for firms that are viewed by creditors as a greater risk and that would suffer from higher bankruptcy costs (Myers, 1984). In the same spirit, it may also be argued that a long-term activity might be associated with higher indebtedness, given that well-established firms have more advantageous loan terms than newer ones. The older the firm (and its reputation), the lower the cost of debt. By contrast, firms that are in a growth phase are perceived as higher risk and experience more unfavourable conditions when attempting to access finance.

In a dynamic setting, the trade-off theory accounts for the adjustment of the debt ratio as a balance between the costs of deviation from the target and the gains of adjustment towards that target. Empirically, firms make a partial adjustment of debt towards the optimal debt ratio (Lopéz-Gracia & Sogorb-Mira, 2008; Ray, 2012). For this to be achieved, the dynamic trade-off theory considers that for each period, the variation of the debt ratio is also explained by the deviation between the actual and the optimal ratio in the previous period.

2.3. The pecking order theory

The pecking order theory asserts that firms demonstrate a preference for using internal finance (such as retained earnings or excess liquid assets) over external finance due to information asymmetries. Information asymmetries imply that external stakeholders consider the firm to be higher risk, thus lowering its value (Myers & Majluf, 1984). If internal funds cannot fully finance investment opportunities, firms may look for and select from the various external finance sources, namely short- and long-term debt and equity, in order to minimize additional costs resulting from information asymmetries.

Under this theoretical framework, accounting variables may also explain a preference for each of the financing sources available to farmers. First, a profitable firm has the capacity to accumulate retained profits and has less need to turn to external finance (Fama & French, 2002; González & González, 2012). Second, firms with growth opportunities must undertake investment projects, which in turn increase their financial needs. As growth opportunities may produce moral-hazard effects and push firms into taking more risks, Myers (1984) argues that they should contain their indebtedness. Third, the variability in farm profitability is associated with a risk of default on debt repayment, which results in a negative relationship between risk and indebtedness (Barry et al., 2000).

In pecking order theory, asset structure is also an important determinant of the financing decision. Tangible assets (e.g. land, buildings, equipment) have a greater liquidation value (Harris & Raviv, 1991). So, the more assets are tangible, the more they may act as collateral for a loan. Moreover, there exists a negative relationship between liquidity and indebtedness of firms (Myers & Rajan, 1998). Firms benefitting from cash and liquid assets prefer to use this internal funding for their investments instead of external financing. Thus, subsidies, which naturally increase farm liquidity, may reduce indebtedness.

The size of the firm can also be an important factor in pecking order theory. Theoretically, size reduces the problems of information asymmetry between managers/owners and creditors, allowing firms to obtain debt on more favourable terms (Myers, 1984). Thus, a positive relationship between size and debt should be expected (Lopéz-Gracia & Sogorb-Mira, 2008; Psillaki & Daskalakis, 2009).

Table 1. Summary of hypotheses according to the trade-off and pecking order theories.

	Expected influence	
Factors	Trade-off theory	Pecking order theory
Land	+	+
Subsidies	+	–
Profitability	+	–
Liquidity	+	–
Tangibility	+	+
Size	+	+
Growth	–	–
Risk	–	–

We summarize the expected relationship between indebtedness and the different variables in Table 1.

3. Empirical framework

This section presents the empirical framework for our study. We start with a presentation of the structure and financing of Polish agriculture. We then focus on the database and the main variables used. Finally, we present our empirical model.

3.1. A presentation of Polish farms and the credit situation of the Polish agricultural sector

Poland is among the most important agricultural producers in the EU (Eurostat, 2019). Its agriculture is characterized by the predominance of small and medium (rarely large) farms with an average land area of 10 hectares. Production is diversified with an emphasis on field crops and livestock (Table 2). Agriculture also provides a significant contribution to national added value and accounts for 10.1% of employment in Poland. Since the communist period, the agricultural sector has undergone important structural changes, with increases in the average size of farms and the intensification of production. However, productivity remains low, which raises issues concerning levels of investment and access to credit for farms in this country (Bórawski et al., 2020; Dannenberg & Kuemmerle, 2010).

Before accession to the EU, Polish farms suffered from limited access to credit and other sources of external financing as well as few possibilities to accumulate internal funds. This had a significant impact on farm production, investment and consumption (Kata, 2011). Polish farmers preferred loans as a source of investment financing that was intended to enlarge, renew and diversify the production potential of their farms. To a lesser extent, loans are also used as a means of financing current agricultural production and maintaining financial liquidity (Kata, 2018). One might infer that other financing sources, such as European and national subsidies, contribute to the funding of structural investments (fi-compass, 2020).

According to the National Bank of Poland (NBP) data, at the end of 2018, the total amount loaned to farms amounted to over 34 billion zlotys (approx. 7.5 billion euros). It is worth noting that the total sum of loans (in nominal terms) grew by as much as 75.4% compared to 2009. Over the same period, average interest rates fell from 10.1% to 5.2%. However, there was still a barrier to accessing medium- and long-term loans

Table 2. Summary of Polish agricultural statistics.

Agricultural characteristic	Year	EU-28	Poland
Farmland (1000 hectares)	2016	172,967	14,406 *(8.3%)*
Farms	2016	10,467,760	1,410,700 *(13.5%)*
Farmland/holding (hectares)	2016	16.523	10.211
Employment (% of national employment)	2016	4.2%	10.1%
Total agricultural output (M€)	2017	432,600	24,938 *(5.7%)*
> Crops (M€)	2017	218,918	11,244 *(5.1%)*
> Livestock (M€)	2017	176,883	13,071 *(7.3%)*
Value added (M€)	2017	188,460	10,273 *(5.4%)*
Export value (M€)	2017	137,900	25,867
Import value (M€)	2017	117,400	17,537

Source: Eurostat (2019) and Statistical Factsheets from the European Commission (2020). The share of Poland's contribution within the EU (28 countries) is italicized in brackets, where available.

as only 12.4% of Polish farmers applied for such loans in 2017–2018, while the EU average was 29.6% (fi-compass, 2020). The dominant component of farmers' debt (70%) is the long-term investment loan with a maturity period of more than 5 years (Polish Ministry of Agriculture and Rural Development, 2019). According to the Polish Financial Supervision Authority (UKNF, 2018), the quality of loans to individual farmers is relatively good and stable due to the high share of preferential loans. It should be noted that cooperative banks account for less than 60% of loans to agriculture and this figure has gradually decreased over the last decade. A fairly broad offer from commercial banks is being well-promoted and is gaining ground on the cooperatives.

3.2. Database

In order to study the capital structure of farms, we use individual and annual data from FADN for the period 2009–2018. These data are the most accurate available at the individual level. It is worth noting that the FADN sample includes only commercial farms, which, by definition, attain a minimum economic size (standard output of at least €4000 in Poland). Furthermore, the sample is based on a defined stratification (geographical location, economic and technical orientation and physical size) and extrapolation factors (weights) are computed.[1] Our sample is thus representative of Polish professional farms, including those specializing in crops and livestock.[2] From the database, we extract all the relevant variables previously used in other studies (Aderajew et al., 2019; Barry et al., 2000; Zhao et al., 2008) in order to test the relevance of the trade-off and pecking order theories when applied to the financing of Polish farms.

Given that our study covers the period following the economic crisis in Europe, we also combine this database with several macroeconomic indicators (Aderajew et al., 2019). We assume that macroeconomic factors play an important role in the timeline of financing and the choice of capital structure. We choose to measure the effect of GDP growth and inflation on indebtedness. These variables are from the World Bank database. Table 3 specifies the variables used to test the hypotheses defined in Table 1 of this paper.

3.3. Econometric modelling

According to the literature (Aderajew et al., 2019; Barry et al., 2000; Katchova, 2005; Tian, 2013; Zhao et al., 2008), the most appropriate models for testing our research hypotheses

Table 3. List of variables used in the analysis.

Variable	Unit	Definition
Year	–	Year of the observation
Leverage	%	Debt-to-asset ratio (financial debts/total assets)
Standard output	€	Standard output
Decoupled subsidies	€	Decoupled subsidies from the 1st pillar of the Common Agricultural Policy
Rural development subsidies	€	Rural development subsidies from the 2nd pillar of the Common Agricultural Policy
Farmland	ha	Agricultural land area
Land	%	Share of land value in total assets
Tangibility	%	Fixed/current assets
Profitability (ROA)	%	Earnings before interest and taxes/total assets
Liquidity	%	Stock-to-sales ratio
Assets	€	Total assets (agricultural land, buildings, machinery, equipment, breeding livestock)
Growth	%	Total investments/assets
Risk	%	Standard deviation/average ROA
Age	Years	Age of farmer
Orientation	Classes	Economic and technical orientation of the farm (field crops, horticulture, livestock, granivores, mixed crop-livestock)
GDP	%	Annual growth of GDP in Poland
Inflation	%	Annual inflation rate in Poland

are panel data regressions, with the debt ratio or leverage (defined here as the debt-to-asset ratio) being the dependent variable. This estimation method allows us to test the two main theories (trade-off and pecking order) simultaneously.

$$\begin{aligned}\text{Leverage}_{it} =& \alpha + (1-\lambda)\text{Leverage}_{it-1} + \beta_1\text{Land} + \beta_2\text{Subsidies} + \beta_3\text{Tangibility} \\ &+ \beta_4\text{Profitability} + \beta_5\text{Liquidity} + \beta_6\text{Size} \\ &+ \beta_7\text{Growth} + \beta_8\text{Risk} + \beta_9\text{Age} + \beta_{10}\text{Orientation} \\ &+ \gamma_1\text{GDP} + \gamma_2\text{Inflation} + T_t + \varepsilon_{it}\end{aligned} \tag{1}$$

where: α is the constant, other variables are farm-specific, macroeconomic factors with β and γ are the respective associated coefficients to be estimated and ε is the error term, which considers individual effects associated with adjustment costs on the basis of the empirical estimation (Heshmati, 2001). In line with the trade-off theory, λ is the adjustment speed to the target leverage. Following Aderajew et al. (2019) and Flannery and Rangan (2006), we assume that λ is constant over time and that $|\lambda|<1$. This implies that farms make a progressive adjustment to their leverage each year, which is consistent with the theoretical framework of this study, namely the trade-off theory.

Estimating equation (1) requires us to account for potential issues that may cause the use of standard ordinary least squares (OLS) or panel regression methods to lead to biased results. First, it is acknowledged that estimators for short-time panel series are inconsistent due to the correlation of the lagged dependent variable with the error term (Nickell, 1981). In particular, this may bias $(1-\lambda)$ towards zero (Aderajew et al., 2019). Second, some endogeneity may exist between the dependent variable (leverage) and other variables, e.g. profitability. Indeed, pecking order theory states that internal funding is preferred to external financing, which is in line with the fact that profitable farms may self-finance using retained earnings. However, such farms may benefit from favourable credit conditions, which may motivate them to borrow money.

This issue may be addressed by using the generalized method of moments (GMM), developed by Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and

Bond (1998). The GMM provides dynamic panel estimators that are suitable for a small number of time periods and a large number of observations (Baltagi, 2013; Bampasidou et al., 2017). The one left-hand-side variable of the equation is dynamic and depends upon its own past realisations. As right-hand-side variables may not be strictly exogenous, they are lagged in order to constitute valid instruments (Roodman, 2009). More precisely, testing several model specifications has shown that at least 2 lags are needed as instruments in order to ensure correct specification of the method. Consequently, time- and farm-invariant parameters are removed. As our sample covers a 10-year period, we use a system GMM, which is more appropriate when applied to samples with a short-time series dimension and also presents better asymptotic and finite sample properties than a difference GMM (Baltagi, 2013). In order to validate the use of additional instruments, the Hansen (1982) test checks for overidentifying restrictions while the Arellano and Bond (1991) test ensures there is no second-order residual serial correlation.

4. Results

In this section, we start by presenting some descriptive statistics. We then develop the results of the econometric modelling and the robustness tests.

4.1. Descriptive statistics

The first striking result is that Polish farms have a very low debt level (Table 4). By the end of 2018, their level of indebtedness was only 10.6% on average, which is common to field crops and livestock production (Figure 1). While indebtedness increases from 2009 to 2018 (except for livestock), it remains at a rather low level overall. Kołoszko-Chomentowska (2014) stresses that farms from the EU-10 (i.e. countries that joined the EU in 2004) are characterized by low indebtedness. Felczak (2015) and Zawojska (2008) explain that this is due to the use of informal sources of capital outside the formal credit market, especially in rural areas. Research carried out at the request of the Polish Office of Competition and Consumer Protection (UOKIK, 2008) shows that popular informal lending channels in Poland include loans from friends and family. Kata and Walenia's

Table 4. Summary statistics for Polish farms.

Variable	Obs.	Mean	Std. Dev.	Min	Max
Leverage	58,476	8.531	9.706	0.000	151.027
Standard output	58,476	106,601	163,624	−830,765	9,161,251
Decoupled subsidies	58,476	16,806	21,717	0.000	641,111
Rural development subsidies	58,476	5,246	12,991	0.000	424,991
Farmland	58,476	27.416	33.066	0.000	772.800
Land	58,476	49.474	17.104	0.000	0.997
Tangibility	58,476	89.205	6.191	0.000	104.182
Profitability	58,476	6.795	7.043	−85.055	317.678
Liquidity	58,388	39.065	21.457	−10.933	100.000
Assets	58,476	1,052,479	1,089,000	27,244	3,280,000
Growth	58,476	0.017	0.080	−159,850	89,790
Risk	33,251	59.029	11.222	−843.222	1,866.307
Age	57,693	43.983	9.501	19.000	84.000

Note: Euro amounts are current euros.
Source: Own calculations based on the weighted Farm Accountancy Data Network (FADN) database 2009–2018.

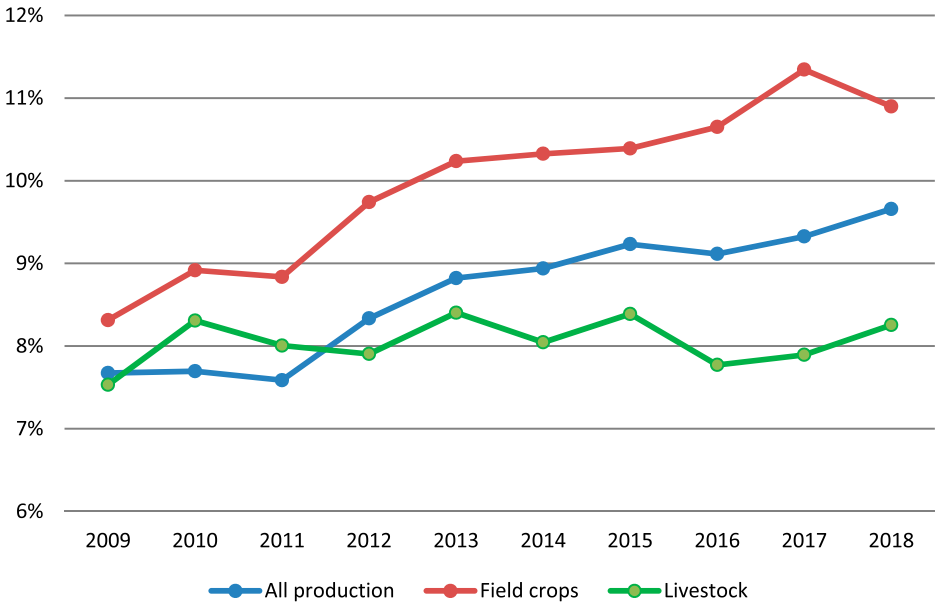

Figure 1. Evolution of farm leverage in Poland between 2009 and 2018. Source: Own calculations based on the weighted Farm Accountancy Data Network (FADN) database 2009–2018.

(2015) in-depth empirical study highlights that financial exclusion, particularly credit exclusion, specifically affects farmers and rural entrepreneurs: nearly 60% of surveyed farmers did not have access to credit, while 64% did not use credit for financing current farm activity and development. This exclusion results from endogenous and institutional credit restrictions and rationing as well as an individual conservative mentality towards credit and an aversion to financial risk (Kata & Walenia, 2015; Soliwoda, 2015).

Polish farms demonstrate relatively high liquidity levels (39%) on average, which denotes control of the volume of stocks and, therefore, capital requirement. Liquidity is also a result of European payments (decoupled and rural development subsidies). Similarly, tangibility is at a high level (89%), which denotes the existence of strong collateral. This is compatible with the average size (measured through total assets) of farms (k€730). By contrast, profitability (measured through the return on assets) is 6.8%. As shown in Figure 2, the decade 2009–2018 was characterized by high volatility in the price of agricultural commodities, including a sudden and persistent drop between 2013 and 2018. This resulted in increased risk and reduced profitability (Hill & Bradley, 2015). As farms adjusted their (capital) structure according to changes in their environment and exposure to risk, a direct consequence was the slow growth of investments in Poland (Kulawik, 2018).

4.2. Econometric results

The results of the econometric models based on equation (1) are presented in Table 5. All statistical tests confirm that the underlying assumptions required for the estimation of the GMM model are satisfied. More precisely, the Wald test is significant at the 1% level for all models, ensuring the whole significance of the model. The assumptions of the Arellano-

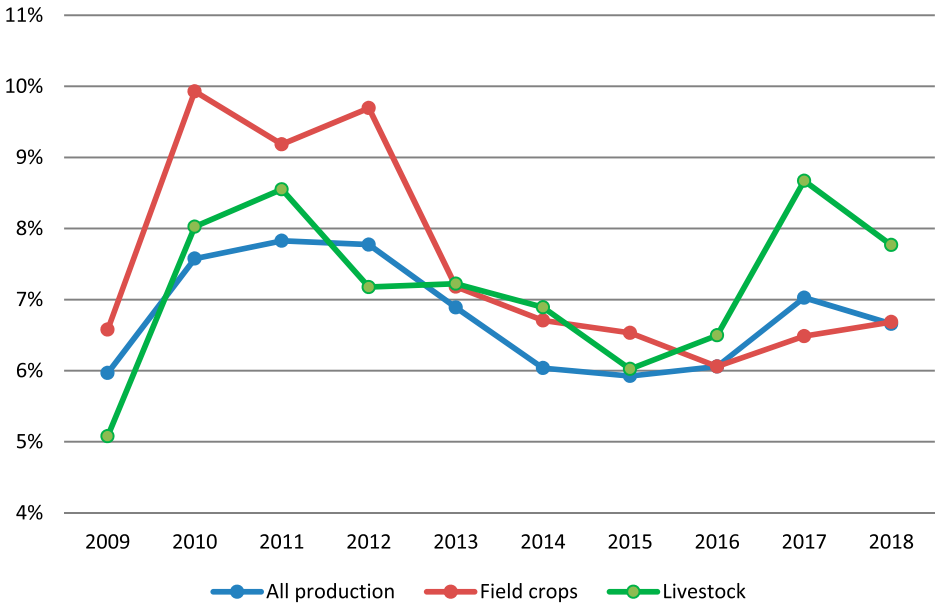

Figure 2. Evolution of farm profitability in Poland between 2009 and 2018. Source: Own calculations based on the weighted Farm Accountancy Data Network (FADN) database 2009–2018.

Bond model regarding the first-order autoregressive correlation and the absence of second-order autoregressive correlation are respected. The Hansen test gauges the validity of the instruments at the 10% level.

All models show a positive and strongly significant effect (at the 1% level) of the lagged leverage (between 0.637*** and 0.737*** depending on the sector). This result may be interpreted as the adjustment speed of leverage. As the value of the coefficient $(1 - \lambda)$ lies between 0 and 1, the leverage converges towards a target level over time. Consequently, each year, farmers adjust their indebtedness. The adjustment rate λ is relatively high in Poland (between 26.3% and 36.3%), which is in line with the moderate indebtedness of farms. It is generally higher for field-crop and livestock production since the risk of these specializations (with a more volatile return on assets – ROA) – translates into a higher adjustment rate.

Farm profitability (ROA) has a strong and negative influence on indebtedness regardless of the type of production (−0.136*** for all farms; all coefficients are significant at a 5% level). In other words, profitability reduces the need for external financing (debt, in our case) by increasing the accumulation of retained profits. This result validates the pecking order theory. Previous studies on farms have noted such effects (Aderajew et al., 2019; Barry et al., 2000; Zawadzka et al., 2015; Zhao et al., 2008). The negative effect of profitability is more important for livestock than for field crops.

Liquidity has no significant effect on indebtedness, even if available cash may sometimes be used as a substitute for debt. We thus find similar results to previous studies of industrial firms (Baker & Wurgler, 2002). In the same vein, European subsidies have no specific influence on indebtedness. This does not prevent Polish farms from increasing their assets using subsidies, but the debt-to-equity ratio remains broadly stable. In

Table 5. Panel regression results.

	Models without macro-economic variables			Models with macro-economic variables		
Variable	All farms	Field crops	Livestock	All farms	Field crops	Livestock
Leverage (−1)	0.720***	0.637***	0.648***	0.737***	0.650***	0.642***
Decoupled subsidies (ln)	−0.005	−0.003	−0.009*	−0.006*	−0.003	−0.008*
Rural development subsidies (ln)	−0.002	−0.001	−0.002	−0.001	−0.001	−0.002
Land	−0.198***	−0.088*	−0.205***	−0.195***	−0.086*	−0.225***
Tangibility	−0.024	0.130	−0.118	0.047	0.127	0.009
Profitability	−0.136***	−0.101**	−0.186***	−0.134***	−0.102**	−0.215***
Liquidity	−0.001	0.001	−0.002	−0.000	0.002	−0.001
Assets (ln)	0.043*	0.075	0.051*	0.050**	0.073	0.054*
Growth	0.328***	0.308***	0.295***	0.309***	0.313***	0.303***
Risk	−0.000	0.000	−0.000	−0.000	0.000	−0.000
Age (ln)	−0.092	−0.170	−0.166*	−0.076	−0.163	−0.164*
Horticulture	−0.215*			−0.140		
Livestock	−0.040			−0.036		
Granivores	0.035			0.052		
Mixed crop-livestock	−0.035			−0.011		
GDP				−0.000	−0.000	0.001*
Inflation				0.000	0.000	0.001
Constant	−0.045	−0.383	0.142	−0.227	−0.387	0.098
Observations	32,787	10,310	8951	32,787	10,310	8,951
Groups	5670	1655	1977	5670	1655	1,977
Instruments	53	53	53	55	55	55
Wald χ^2	1687.79***	552.78***	1468.85***	1658.65***	569.24***	1466.96***
Arellano-Bond test for AR(1)	−6.43***	−3.03***	−6.04***	−6.47***	−3.09***	−6.06***
Arellano-Bond test for AR(2)	0.05	1.10	1.45	−0.07	−1.06	1.46
Hansen test *(p-value)*	36.95 *(0.471)*	43.40 *(0.370)*	46.87 *(0.244)*	43.43 *(0.216)*	43.42 *(0.357)*	38.76 *(0.571)*

Notes: *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively. (−1) and (ln) denote a lagged variable and a natural logarithm, respectively. Arellano and Bond (1991) is the test for second-order serial correlation in the first-differenced residuals. Hansen (1982) is the test for overidentifying restrictions. AR(1) and AR(2) respectively stand for first- and second- order autoregressive correlations. A system generalized method of moments (GMM) was used and the following variables were considered as potentially endogenous with the dependent variable: decoupled subsidies, rural development subsidies, land, tangibility, profitability, liquidity, assets, growth, risk, GDP and inflation. These variables were used in difference and level equations. At least 2 lags were selected for the estimations.

Source: Own calculations based on the weighted Farm Accountancy Data Network (FADN) database 2009–2018.

contrast to the results of Latruffe et al. (2010), we find that subsidies do not have ex-post coupled effects through an income multiplier effect on credit-constrained farmers. Polish farmers do not seem to use subsidies as a way to significantly increase their indebtedness and thus their capacity to finance their fixed assets. This situation is probably indicative of the credit constraints that affect Polish farmers.

For most models, the share of land value in total assets has a significant negative influence on indebtedness. At first glance, this result may seem surprising insofar as land ownership may be considered as potential collateral. This may indicate that farmers who own a high share of productive land are less likely to seek additional indebtedness. Thus, the effect of tangibility on indebtedness is not significant for all farms and types of productions. Given that most Polish farms do not borrow large amounts of money, tangibility is not necessarily seen as collateral.

As, on average, Polish farms are not much indebted, an increase in size results in a relatively greater need for funding, especially through debt. Growth opportunities also play a very significant positive role in indebtedness for all sectors. This result contradicts both the trade-off and pecking order theories but may be explained by the fact that farmers seem to use investments as a positive signal for lenders. Farm investments (e.g. tractors, milking stations) are usually new fixed assets that basically improve a farm's efficiency and productivity (Barry et al., 2000). Thus, these investments are often considered as a source of future cash flow that will secure payback of the debt and the associated interest (Aderajew et al., 2019). Taken together, these results point to the fact that the farms that are most concerned with self-development, such as production intensification, are the most interested in access to credit.

Finally, risk (volatility of ROA) seems to have no significant influence on indebtedness. This result may denote information asymmetries: in an adverse selection context, the highest risk farms (e.g. those facing unfavourable weather conditions or volatile input and output market prices) may also apply for loans as long as they have sufficient tangible assets to offer as collateral. Considered as control variables, neither the age of the farmer nor the farm's specialization appear to negatively influence indebtedness. One important result is that the relative influence of all the considered factors on indebtedness is almost the same across all sectors and types of farms. This point illustrates the weight of the historical system of agricultural production on the financial policies of Polish farms today, even though agricultural collectivization has been increasingly abandoned in Poland since the 1960s.

The use of macroeconomic variables as determinants of leverage does not affect previous results. Inflation has a significant positive effect on indebtedness for field-crop farms only. This result may stem from inflation levels observed in the EU following the financial crisis, which, on average, were moderate in Poland (2.38%) between 2009 and 2018. Low inflation causes nominal and real prices to be similar, which does not provide a significant incentive to become indebted, even though interest rates are also low. The low GDP growth rate (3.45% on average in Poland between 2009 and 2018) is correlated with reduced investments and lower financing needs. Our results are in line with those of Aderajew et al. (2019), who found mixed results for these factors. Although we cannot precisely measure this with the data at our disposal, it is likely that the indebtedness of Polish farms is mainly influenced and

constrained by major external events such as the 2008 financial crisis and the 2013 global food price crisis.

4.3. Robustness tests

We perform some robustness tests in order to check for differences in estimates according to standard output (economic size), physical size, workforce, growth and the time period (Table 6). To do this, for each test, the overall sample of farms was split into two subsamples.[3] The results for both subsamples generally keep the sign and significance of previously estimated coefficients.

Overall, the significance of the results does not change according to the size (economic, physical and workforce) and growth opportunities of farms. The adjustment levels are lower for the largest and most dynamic farms because they clearly benefit from easier access to credit. Consequently, the pecking order theory is only partially validated for Polish farms: while land, profitability, size and growth appear to be important determinants of their capital structure, European subsidies, liquidity and risk are not significant. At the same time, farms seem to target and adjust debt levels, thus validating the trade-off theory. These results contrast with Weill (2005), who studied the determinants of capital structure in Eastern and Western Europe and observed the lack of significance of tested factors in the former compared to the latter. They also differ from Hernádi and Ormos (2012), who found no strong trade-off considerations in financing decisions in their sample of Central and Eastern European firms. It is likely that the gradual increase in the indebtedness of Polish farms leads to the identification of trends that were not previously detectable in earlier studies.

In addition to these robustness tests, Figure 3 presents the results of a quantile regression with panel data, together with 95% confidence interval for the total sample of Polish farms. It can be seen that indebtedness consistently increases with tangibility and growth across the quantiles. Land and profitability have an inverse effect on debt. For these key variables, the results confirm and strengthen those of panel regressions (Table 5). The shape and slope of the graphs indicate the non-significance of rural development subsidies and risk, which aligns with the findings in the main models. Moreover, the magnitude of change is small regarding decoupled subsidies, liquidity and the farmer's age. Thus, these three parameters are also not significant.

5. Conclusion

In this article, we study the indebtedness of Polish farms by focusing on this specific and crucial source of financing. This work is based on corporate finance literature and tests the validity of the trade-off and pecking order theories when applied to the capital structure of farms. Using the FADN database 2009–2018 for Polish farms, a dynamic partial adjustment model estimates the influence of key factors on indebtedness according to the theoretical framework. Estimates are based on the generalized method of moments (GMM), which is suitable for a small number of time periods and a large number of observations.

Polish farms are among the least indebted in Europe but their indebtedness increases constantly over time, with the exception of livestock production. The results show that

Table 6. Robustness tests.

	Standard output		Growth		Workforce		Size	
Variable	Small	Large	Low	High	Small	Large	Small	Large
Leverage (−1)	0.672***	0.859***	0.639***	0.791***	0.668***	0.754***	0.681***	0.754***
Decoupled subsidies (ln)	−0.005	−0.005	−0.006	−0.004	−0.004	−0.002	−0.005	−0.002
Rural development subsidies (ln)	−0.001	−0.000	0.001	−0.004	−0.001	−0.001	0.004	−0.001
Land	−0.051*	−0.212***	−0.321***	−0.016	−0.130***	−0.314***	−0.251**	−0.314***
Tangibility	−0.044	0.015	0.038	−0.224*	−0.061	0.153	−0.016	0.153
Profitability	0.125***	−0.202***	−0.124***	−0.206***	−0.139***	−0.159***	−0.119**	−0.159***
Liquidity	0.003	−0.005	0.009	−0.022	−0.008	0.017	0.012	0.017
Assets (ln)	0.042	0.028	−0.018	0.013	0.036*	0.066*	0.031	0.066*
Growth	0.295**	0.415***	0.257***	0.476***	0.354***	0.299***	0.187***	0.299***
Risk	−0.000	−0.000*	0.000	−0.000*	−0.000	−0.000*	0.000	−0.000*
Age (ln)	−0.128*	0.051	−0.169*	−0.131	−0.153*	0.004	−0.104	0.004
Horticulture	−0.177	−0.177	−0.509	−0.191	−0.168	−0.162	0.002	−0.162
Livestock	−0.035	−0.122	−0.129*	−0.033	−0.039	−0.003	−0.011	−0.003
Granivores	0.061	−0.070	0.027	0.031	−0.017	0.119	0.081	0.119
Mixed crop-livestock	−0.002	−0.045	−0.050	0.007	−0.054	−0.018	0.045	−0.018
Constant	0.139	−0.370	1.158	0.636	0.336	−0.867*	−0.094	−0.867*
Observations	14294	18493	22181	10606	19551	13236	8402	24385
Groups	2982	3240	5124	3325	3987	2694	1681	4245
Instruments	53	53	53	53	53	53	53	53
Wald χ^2	861.33***	1681.46***	995.61***	979.66***	1309.23***	701.32***	548.74***	2014.09***
Arellano-Bond test for AR(1)	−4.65***	−3.61***	−4.44***	−5.50***	−4.80***	−2.95***	−3.94***	−6.68***
Arellano-Bond test for AR(2)	−1.00	1.38	−0.43	0.92	−0.45	1.62	−0.91	0.99
Hansen test *(p-value)*	31.81 *(0.711)*	21.40 *(0.844)*	40.57 *(3.316)*	48.03 *(0.106)*	22.28 *(0.973)*	34.52 *(0.221)*	38.76 *(0.390)*	23.14 *(0.770)*

Notes: *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively. (−1) and (ln) denote a lagged variable and a natural logarithm, respectively. Arellano and Bond (1991) is the test for second-order serial correlation in the first-differenced residuals. Hansen (1982) is the test for the overidentifying restrictions. AR(1) and AR(2) respectively stand for first- and second-order autoregressive correlations. A system generalized method of moments (GMM) was used and the following variables were considered as potentially endogenous with the dependent variable: decoupled subsidies, rural development subsidies, land, tangibility, profitability, liquidity, assets, growth and risk. These variables were used in difference and level equations. At least 2 lags were selected for the estimations.

Source: Own calculations based on the weighted Farm Accountancy Data Network (FADN) database 2009–2018.

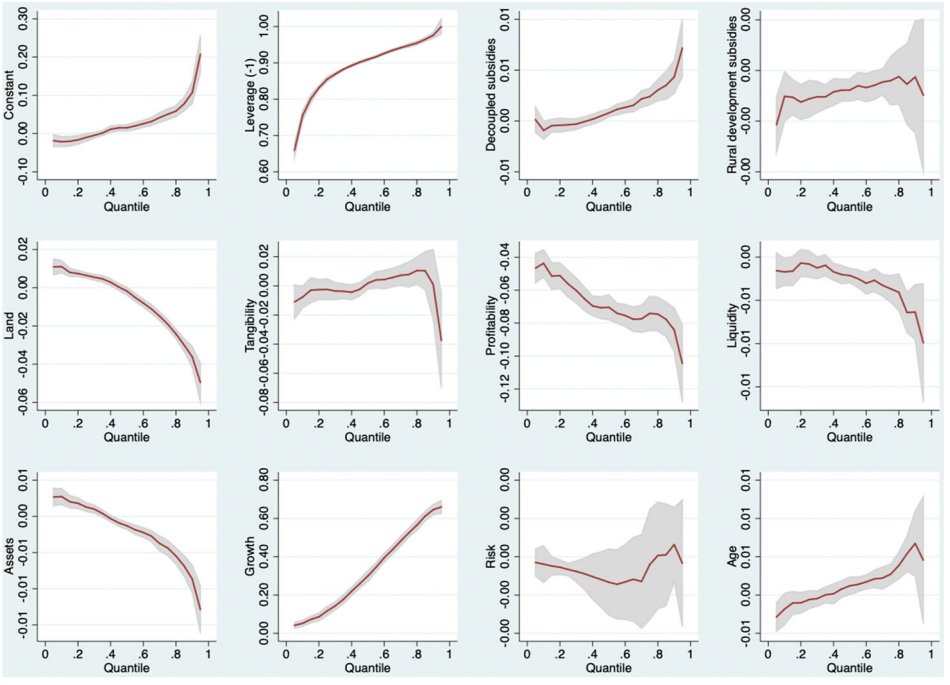

Figure 3. Quantile regressions for indebtedness. Source: Own calculations based on the weighted Farm Accountancy Data Network (FADN) database 2009–2018.

profitable farms are less indebted. Indeed, profitability encourages retained earnings and reduces the need for external financing, in line with the pecking order theory. Growth opportunities play a significant positive role in indebtedness for all specializations. Investments thus send a positive signal to lenders, indicating future cash flow. This result may be explained by the specificity of farm investments, which are considered as a means of securing debt repayment. Some parameters, such as subsidies, tangibility, liquidity and risk, have little or no influence on indebtedness. The age of the farmer and macroeconomic variables (GDP and inflation) do not significantly affect indebtedness either.

Lagged leverage has a strong influence on current leverage in all sectors. This result may be interpreted as an annual adjustment of debt towards a target level. The adjustment rate is quite high in Poland, especially for field-crop production. As, on average, Polish farms have low levels of indebtedness, they can adjust their leverage more dynamically. These results emphasize the validity of the trade-off theory and some of the pecking order theory when applied to farms. They also have implications for public policies.

In Poland, barriers to the modernization of farms could be resolved if farms were able to obtain better access to credit in order to finance their projects and benefit from a leverage effect. Banks need to propose loans tailored to the needs of farmers and also prioritize the development of long-term relationships. At the same time, public authorities could create a regulatory and supervisory framework that would encourage banks to become more involved in providing financial services in rural areas. The Polish 'Strategy for sustainable rural development of agriculture and fisheries 2030', adopted by Resolution

No. 123 of the Council of Ministers on 15 October 2019, promotes a wider use of financial instruments, including preferential loans and loan repayment guarantees.

Finally, European subsidies could also play a key role in helping the financing of farms. Indeed, unconventional monetary policies (including ongoing quantitative easing by the European and Polish central banks) have led to low interest rates in the EU. Under a constrained CAP budget, these low rates may encourage the financing of farm investments and activities at a limited cost through the credit channel (Mamatzakis & Staikouras, 2020). Future research could consider these changes through a long-term analysis of the dynamics of indebted farms.

Notes

1. More information on the organization of the Polish FADN can be found on its website: http://fadn.pl/en/organisation/polish-fadn/organizacja-polskiego-fadn/.
2. A farm is considered to be specialized when a particular activity provides at least two-thirds of the production or business size of the agricultural holding.
3. Criteria are considered as large/high when the standard output is higher than €55,000 (median value in Poland), growth is positive, the number of workers is higher than 2 full-time equivalent (median values), and the land area is larger than 23 hectares (median values).

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Local business environment, managerial expertise and tax corruption of small- and medium-sized enterprises

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ABSTRACT

While tax corruption is widespread in many countries with inferior business environments, it is unclear how the characteristics of taxpayers influence their tax behaviour. This study investigates the impact of manager expertise on firms' tax corruption in a transition economy. Using a longitudinal dataset consisting of small- and medium-sized enterprises in Vietnam over the period from 2005 to 2015, we find that firms which are managed by more able managers are more likely to engage in tax corruption and are willing to offer higher amounts of bribe payments. We also find that improving the quality of the local business environment is associated with lower tax corruption. When the quality of the local business environment is improved, managers with greater knowledge of existing laws and regulations, and more working experience, engage less in tax corruption. Our findings imply that improving the quality of the local business environment is important for reducing tax corruption in transition economies.

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1. Introduction

Tax evasion is rampant in many countries, causing estimated losses of US$200 billion in annual revenue (Cobham & Janský, 2018). This poses serious challenges on the ability of countries to finance public services as well as to meet their development objectives. One of the major causes of tax evasion is corruption in taxation – a phenomenon where corrupt tax officials and the bribers negotiate to reduce tax liabilities. Arguably, firms have a high incentive to bribe tax officers if the cost of bribery is compensated by the benefit from a reduced tax payment (Gauthier & Goyette, 2014). Nevertheless, this practice can be costly for firms because it may attract the regulators' attention and sanctions. In addition, firms may not get 'good value for their money' due to the unofficial nature of the payment (Rodriguez et al., 2005). At the macro level, tax corruption is deemed as undesirable since it could cause a serious budget deficit and a misallocation

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in budget distribution, which would therefore hamper the ability of a government to provide public goods and services (Ajaz & Ahmad, 2010). Thus, understanding the driving forces behind corporate tax corruption behaviour is important for tackling tax evasion.

Previous studies often attribute the importance of corporate managers for explaining the practice of corruption (De Jong et al., 2012; Powers et al., 2016; Hanousek et al., 2019; Luu et al., 2019). These studies show that firm managers have significant individual effect on various corporate decisions, including the tax strategies (Powers et al., 2016) as well as the decision to bribe corrupt officials (Hanousek et al., 2019). In principle, firm managers consider the cost–benefit trade-off when deciding the extent to which they should involve themselves in tax corruption, and these considerations can largely stem from each manager's expertise and experience (Chavis, 2013).

However, to what extent managers' expertise actually shapes the tax corruption practice of individuals firms is still largely controversial. A strand of literature documents a positive association between managers' expertise and corruption. These studies show that while the risk and uncertainty associated with corruption is high, more able managers can exploit their superior cognitive skills and knowledge of working with government officials to reduce the uncertainties and ambiguities in corruption (De Jong et al., 2012; Luu et al., 2019). In addition, managers with better knowledge about the laws and the legal system can be more knowledgeable of the ambiguities and loopholes in existing laws and regulations to find tax evasion opportunities (Borrego et al., 2017). On the other hand, another strand of the literature suggests that the education and experience of managers are associated with moral development and the ability to use formal strategies in doing business (Karami et al., 2006; Tu, 2012). In this regard, managers with greater expertise are less likely to be involved in tax corruption (Treisman, 2007; Glaeser & Saks, 2006). In a similar vein, several other studies also provide evidence that tax knowledge is positively associated with tax compliance attitudes and behaviour (Newman et al., 2018).

These mixed findings in the relevant literature might be attributable to the fact that most empirical works have thus far failed to take the interaction between the *internal* influence of manager expertise and the *external* impact of the local business environment into account. While doing business, firms would need to operate in the business environment governed by the local government authorities, including the tax authorities. The relationship between tax corruption and local institutions has been documented in prior literature. For example, Tanzi and Davoodi (1998) and Mawejje and Okumu (2016) suggest that tax corruption and institutional quality are negatively related. This is because a complex and fragmented tax system may allow tax officials to make use of the unclear and equivocal interpretation of laws to impose a higher demand for bribery on taxpayers (Awasthi & Bayraktar, 2014). In this context, high tax rates and complicated tax procedures are perceived obstacles to doing business. These obstacles subsequently incentivise firms to pay bribes to relieve their tax burdens (Ajaz & Ahmad, 2010). Given that the manner in which firms' responses to external influences from the local business environment should be shaped by their managers, failing to take into account the role of the local business environment's quality when examining the impact of managerial expertise on tax corruption could hamper the breadth and accuracy of the empirical studies. Therefore, in this study, we fill the gap in the literature by investigating how

manager expertise interacts with the local business environment to determine the level of tax corruption practice of firms.

We test model implications with a comprehensive micro-dataset on the Vietnamese private sector. This country provides a natural testing ground for us to examine the impact of manager expertise and local business environment on tax corruption due to its interesting (and representative) institutional background and also due to its neglect in prior empirical research. Vietnam is a socialist country under the sole leadership of the Communist Party. The country has gone through a transition process from a centrally planned economy to a market economy since the 'Doimoi' (Renovation) political and economic reform in 1986. Concurrent with the boom of the private sector, Vietnam has implemented various policy reforms over the past few decades aiming to tackle administrative inefficiencies and facilitate the development of private sectors. However, similar to many former Soviet states, including Azerbaijan, Kazakhstan, Russia and the Baltic countries, Vietnam still has a weak institutional system, widespread corruption and a significant state budget deficit. Despite the tremendous effort by the government, Vietnam still experiences a tax revenue loss of US$900 million per year due to tax evasion (Nguyen, 2020). Anecdotal evidence shows that corruption in taxation is rampant in Vietnam and is one of the main causes of tax evasion (Nguyen et al., 2017). A survey conducted by the World Bank and the Government Inspectorate of Vietnam (2012) revealed that taxation is among the most corrupt sectors in Vietnam, and the majority of businesses are actively involved in bribery against taxation. Given the fact that small- and medium-sized enterprises (SMEs) accounts for 98% of the total number of registered enterprises in Vietnam (VEN, 2016) and most of the business-government interactions take place at the local jurisdiction level rather than the national level (Bai et al., 2019), our study aims to evaluate how the expertise of Vietnamese SMEs' managers influence their tax corruption practices in different local business environments.

We exploit the unique longitudinal firm-level data of 14,673 firm-year observations covering 4939 SMEs from the SME surveys conducted in Vietnam during the period from 2005 to 2015 to test our models. The result reveals that firms led by more able managers are more likely to engage in tax corruption and are willing to pay a higher bribe to corrupt tax officials. Meanwhile, we also find that tax corruption practice is significantly lowered when the quality of the local business environment improves. More importantly, we demonstrate that firms led by more able managers with a higher level of education, greater knowledge of existing laws and regulation, and more working experience reduce their tax bribery incidences and pay smaller amounts of tax bribery when they operate in a better local business environment.

Our study is closely related to the body of literature that associates the knowledge of taxpayers to tax compliance (Borrego et al., 2017; Newman et al., 2018). As general and specific knowledge (i.e. knowledge of laws and regulations) can both determine a tax briber's benefits and costs associated with corrupt activities (Kaufmann & Wei, 1999; De Jong et al., 2012; Luu et al., 2019), bribers who have different levels of knowledge are likely to behave differently. Although these studies show a common finding that the more knowledgeable taxpayers tend to comply better with tax regulations (Newman et al., 2018), we contribute to this literature by showing that more able managers can take advantage of their knowledge and expertise to spot any non-compliance opportunities and engage in bribery against taxation.

This paper also contributes to the literature by examining how the quality of the business environment can act as an important determinant of corruption. It is widely agreed that a low-quality business environment, characterised by bureaucratic burdens, a lack of financial support, and inefficient court and legal systems, may nurture corruption (Tonoyan et al., 2010; Dutta & Sobel, 2016; Bologna & Ross, 2015). Therefore, when the quality of a local business environment is improved, corruption is less likely to occur (Bjørnskov, 2011). Our study provides support for these propositions. More importantly, we augment the prior literature by documenting that managers with different levels of expertise can exploit the different business environments to determine the extent to which they can become involved in tax corruption.

Although we conduct our studies using a single country setting (i.e. in this case, Vietnam), we believe that our results can have broader implications for other countries with a historic political linkage and a relatively similar institutional environment, such as the post-Soviet states, including Russia and the Baltic countries.

The remainder of the paper is structured as follows: the second section presents a theoretical framework to analyse the effects of a local business environment on tax bribery behaviour of firms' managers. Section 3 presents the methodology and data. Section 4 discusses the empirical results. Section 5 provides several additional analyses, and Section 6 concludes the paper.

2. Theoretical framework

Theoretical work on the motivation for bribery has suggested that enterprises/individuals try to maximise profits/utility when participating in the activity (Becker, 1968; Kaufmann & Wei, 1999). It is reasonable to expect that the willingness of a firm to pay bribes is positively determined by the expected net benefits obtained from the bribe payment. Thus, we propose a model of bribe propensity as follows:

$$p_i = f(EB_i, e_i) \tag{1}$$

in which i denotes firm i, p_i is the probability of firm i engaging in bribery, EB_i is the expected net benefit of the bribe deal and e_i is the unobserved error term. As suggested by the literature on the determinants of corruption (Kaufmann & Wei, 1999; Tanzi & Davoodi, 1998; Treisman, 2007), EB_i can be calculated as follows:

$$EB_i = Pr(b)_i \times B_i - C_i - \Pr(p)_i \times P_i, \tag{2}$$

where B_i is the benefit that firms might obtain from public officers if the corrupt deal is successful. These benefits might vary, including the relief of administrative procedures and regulatory burden, policy incentives, government contracts and public support (Lui, 1985; Tanzi & Davoodi, 1998). $Pr(b)$ is the probability that firms successfully obtain the services or favours for which they have paid the bribe. This probability represents the uncertainty and ambiguity associated with corruption, depending on whether the corrupt public officers have adequate power to give firms exactly what they wanted, and whether they keep their promises (Rodriguez et al., 2005; Luu et al., 2019). C_i is the cost of the bribery consisting of both the amount of the payment made to the corrupt public officers, and also the management effort wasted in finding and negotiating with the corrupt public officers (Kaufmann & Wei, 1999). Since such costs are unable to be recovered regardless of the

outcome of the deal, C can be considered as a sunk cost that is independent of *Pr*(*b*), which is the probability of the favours being delivered. P_i is the cost of punishment once firms are convicted of the illegal act. The punishment is defined by law in accordance with the degree of severity of the corruption. Hence, we have a reason to assume that the cost of the punishment is consistent across different local business environments. *Pr*(*p*) is the probability of the corrupt deal being exposed and firms are subject to punishment by law (Tonoyan et al., 2010). This probability is determined by the strength of the law enforcement by the local business environment in which the firms operate.

A deteriorating business environment which is characterized by regulatory burdens, weak rules of law, an inefficient government, and a lack of transparency and public support can foster corruption from both the demand and supply side (Treisman, 2007; Bjørnskov, 2011). Poor oversight mechanisms, inconsistent enforcement, and varied interpretations of laws and policies can give public officers tremendous discretionary powers over public goods and services so that they can be in a position to demand bribes (Ahrens, 2000; Boly & Gillanders, 2018). On the supply side, as corruption plays an efficient grease-the-wheel role, thus allowing firms to overcome institutional weaknesses, firms generally have a high incentive to bribe (Dutta & Sobel, 2016; Bologna & Ross, 2015). Although there is ample room to take advantage of bribery, the expected benefit of bribery might be contingent upon the knowledge levels of a firm's managers. The knowledge level, which is enhanced through education and working experience (De Jong et al., 2012), refers to the general competence base, the formal knowledge of laws and regulations, and the tacit knowledge of the ways of doing business in the local context.

Under a deteriorating local business environment, legal knowledge allows managers to be aware of loopholes in laws and public policies so that they can be better at bending the rules or pursuing rent-seeking behaviour, which subsequently results in larger benefits being gained from bribery. In addition, the managers with greater cognitive skills, awareness capabilities and the tacit knowledge of doing business can maximise the chances of success by choosing the right public officers who are capable of delivering the requested services and favours (De Jong et al., 2012; Luu et al., 2019). Although the prevalence of corruption can put firms under the risks of bribe extraction by bureaucrats (Rodriguez et al., 2005), a strong local sense might enable the bribers to identify the appropriate amount of payment better and reduce the cost of bribery (Luu et al., 2019). Moreover, through past experience of engaging in briberies, firm managers might develop social ties with local public officers, which facilitates trust and reciprocal obligations (Collins et al., 2009). This might subsequently enhance the likelihood of the officers adhering to the deal while reducing the risk of being exposed. The established social ties also save firms' managerial efforts in first finding and then negotiating with public officers. Thus, the more knowledgeable managers are able to gain a higher benefit (higher *B*), a greater chance of bribery success (higher *Pr*(*b*)), a lower cost (*C*) and a lower probability of being exposed (lower *Pr*(*p*)); thereby, they have a higher propensity for engaging in bribery.

However, a high-quality local business environment might diminish the intent for bribery, regardless of the knowledge levels of the firm managers. This might be because the opportunities for corruption are substantially restricted under an improved environmental context, so that managers are no longer able to use their competence and experience to make use of bribery. Specifically, laws are clearly codified and implemented consistently across government units, giving public officers no discretionary

power that can be used in exchange for bribe payments. Despite the legal knowledge, firm managers are not able to find loopholes and rent-seeking opportunities which they can use as bribes, so the gains from bribery become limited. In addition, since the expected risk of getting caught and the punishment is high under an efficient law enforcement and court system, few public officers are willing to commit such illegal activities. As a result, the probability of finding a corrupt public officer is low even for firm managers with more knowledge and experience. As for the bribers, strong law enforcement increases the probability of detection and punishment to the extent that it cannot be concealed by social ties with the public officers or tacit knowledge of the business environment. Thus, under an improved business environment, the benefit of bribe B and the chance of success $Pr(b)$ is low, while the risk of punishment $Pr(p)$ is high for both firms either with or without high levels of managers' knowledge; one might therefore expect to observe insignificant differences in bribe propensity between the two groups.

In this paper, we postulate that when a firm operates in an improved-quality local business environment, its managerial expertise is negatively associated with tax corruption. Arguably, an improved quality of the local business environment would limit the chances of managers using their expertise to take advantage of corruption. Previous studies show that the ambiguous interpretation of laws and the inconsistent law enforcement that gives public officials the discretionary power in the delivery of public goods and services are the main causes of corruption (Ahrens, 2000; Boly & Gillanders, 2018). Therefore, in a higher-quality business environment, where the law is clearly codified and strictly enforced, corruption opportunities are limited. In addition, while firms can make use of corruption to overcome rigid and cumbersome regulations (Dutta & Sobel, 2016; Bologna & Ross, 2015), the expected benefit from engaging in bribery is diminished when the regulatory burden is relieved under the local business environment with improved quality. Moreover, under such an environmental context, the risk of being detected and punished associated with the engagement in corruptive activities is also higher due to better law enforcement and a more efficient court system. Thus, involvement in corruption is a costly 'investment activity' with lower expected profits. In this regard, more able managers could have more incentives to focus on their expertise in capturing market opportunities and conducting mainstream business rather than looking around for ambiguous unofficial opportunities such as corruption. Since managers with a high level of expertise are more capable of using formal strategies in doing business (Karami et al., 2006; Tu, 2012), we expect that firms run by more able managers are less eager to commit to tax corruption activities when the quality of the local business environment is improved.

3. Model specification and data

3.1. Model specification

To investigate the impact of managers' expertise and the local business environment on firm tax corruption, we adopt the following standard regression model:

$$\begin{aligned} Tax\ Corruption_{it} = {} & \delta_0 + \delta_1 Manager\ Expertise_{it} + \delta_2 Business\ Environment_{pt} \\ & + \delta_3 Manager\ Expertise_{it} \times Business\ Environment_{pt} + \delta_3 Controls_{it} \\ & + Fixed\ Effects + \varepsilon_{it} \end{aligned} \tag{3}$$

where *i* denotes firm, *p* denotes province and *t* denote year. In our study, we consider corporate tax corruption using two aspects: (i) probability of engaging in tax corruption and (ii) amount of tax corruption. The survey data, which will be discussed in more detail in the subsequent section, provide us with sufficient information for our empirical analysis. For instance, firms are asked whether they participate in tax corruption activities: 'Did you have to pay informal/communication fees?' and 'Was the bribe payment/communication fee mainly used for dealing with taxes and taxation?' Responses to these questions are recoded as binary variables, taking the value of 1 if firms are involved in tax corruption and 0 otherwise. Thus, our first measure of tax corruption is *Bribery*, which is a dummy variable equal to 1 if the firm pays informal fees mainly used for dealing with taxes and taxation, and 0 otherwise.

Meanwhile, firms were also asked about the extent to which they paid funds to a corrupt tax officer: 'Approximately how much did you pay in total?' Thus, our second measure of tax corruption is *Bribery Amount*, which is the natural logarithm of the amount of the bribe payment to deal with taxes and tax collection plus 1.[1]

In our model, *Tax Corruption* is regressed on *Manager Expertise*, *Business Environment*, and the interaction term between *Manager Expertise* and *Business Environment*. *Manager Expertise*, which will be discussed in the subsequent section, measures firm managers' general knowledge attained through formal education, specific knowledge of law and knowledge accumulated from working. Higher values indicate higher manager expertise.

Meanwhile, *Business Environment*, which will also be discussed in more detail later, measures the capability of local governments to create a favourable business environment for promoting development of private firms. A higher *Business Environment* value reflects a better business environment for firms in terms of the following aspects: low entry costs, easy land access, high transparency, low corruption and low administrative burden. It also indicates less bias towards state enterprises, governments being more proactive, and high-quality business support services and labour training policies.

Our main variable of interest is the interaction term *Manager Expertise* × *Business Environment*. It captures the moderating effect of local business environment quality on the relationship between manager expertise and firms' behaviour in tax corruption. A negative (positive) and significant coefficient on *Manager Expertise* × *Business Environment* would indicate that, when the business environment quality is improved, firms with a higher manager expertise are less (more) eager to participate in tax corruption.

We also incorporate a list of control variables comprising enterprise characteristics that might influence the bribe behaviour of enterprises as suggested by the appropriate literature. Specifically, we incorporate the vector $Control_{it}$ = [*Firm Age, Firm Size, ROA, Leverage, Export, Professional Staff, Business Association, Manager Gender, Manager Age*]. Table 1 represents the definitions of the main variables. Various types of fixed effects are incorporated into the specifications, including province fixed effects, industry fixed effects, year fixed effects and industry-year fixed effects. Finally, standard errors are clustered at the firm level.

3.2. Measuring managers' expertise

We measure manager expertise based on the following three aspects: (i) general knowledge acquired through formal education; (ii) specific/informal knowledge of laws and regulations; and (iii) specific/informal knowledge acquired through work. These aspects

Table 1. Variable description.

Variables	Description	Source
Bribery	A dummy variable, equal to 1 if the firm paid bribes to deal with taxes and tax collection, 0 otherwise	SME survey
Bribery Amount	The natural logarithm of the amount of bribe payment to deal with taxes and tax collection plus 1.	SME survey
Manager Expertise	The constructed variables capturing the expertise of a firm's manager in terms of general education, specific knowledge, and work experience.	SME survey
Business Environment	The natural logarithm of provincial competitiveness index (PCI)	PCI data
Firm Age	The natural logarithm of number of years as an establishment plus 1	SME survey
Firm Size	The natural logarithm of total assets	SME survey
ROA	The ratio of revenue to total assets	SME survey
Leverage	The ratio of total debt to total assets	SME survey
Export	A dummy variable, equal to 1 if the firm exported its products, 0 otherwise	SME survey
Professional Staff	The ratio of professionals to total employees	SME survey
Business Association	A dummy variable, equal to 1 if the firm was a member of a business association, 0 otherwise	SME survey
Manager Gender	A dummy variable, equal to 1 if the firm's manager is a male, 0 otherwise	SME survey
Manager Age	The natural logarithm of the age of a firm's manager	SME survey

have been used conventionally in the previous literature to assess how the managers' expertise determines the level of tax compliance and tax corruption practices (De Jong et al., 2012; Borrego et al., 2017). For example, De Jong et al. (2012) suggest that a higher level of education implies greater cognitive skills and awareness capabilities that allow managers to seize bribery opportunities, leading to a higher propensity of more educated managers to bribe. The knowledge of tax laws can be used to discover ambiguities and loopholes in tax laws for tax evasion opportunities and induce non-compliance behaviour (Borrego et al., 2017). Other studies also link the relationship between managers' working experience and the tendency for them to bribe since the experience at work allows managers to acquire the tacit knowledge and information of corruption practices in their business environment (De Jong et al., 2012; Tu, 2012).

In the survey, managers were asked 'What is the highest level of education you have completed?' The answer for this question would indicate the general knowledge acquired from the formal education of the firm managers. We encode the answer for this question so that it equals 1 if the firm manager obtains a university (or higher) education level, and 0 if the manager's education level is lower than the level of a university.

With regard to the managers' specific knowledge of laws and regulations, managers were asked, 'How would you characterise your knowledge about the following laws and government regulations: (a) enterprise law, (b) cooperative law, (c) labour code, (d) customary law, (e) insurance law, (f) tax law, (g) environment law, (h) land law, (i) investment law, (j) social insurance law and (k) gender equality law?' The respondents can choose either one of the following answers: (i) *good*; (ii) *average*; (iii) *poor*; and (iv) *no knowledge/not of my interest*. We encode the answers for this question as 1 if the manager responds as having good knowledge of at least one of the mentioned laws, and 0 otherwise.

Finally, the experience of managers may also constitute the specific knowledge required to participate in tax bribery. In the survey, managers were asked: 'Did the owner of the enterprise work with similar products/services prior to establishing the present enterprise?'.[2] The respondents can choose to answer either '*Yes*' or '*No*'. We encode the answer for this question so that it equals 1 if the manager responds that

they had experience of working with similar products/services prior to establishing the business, and 0 if the answer is '*No*'.

To capture managers' expertise, we introduce a *Manager Expertise* variable. It is a composite index based on all of the three aspects mentioned above. *Manager Expertise* takes the value ranging from 0 to 3. The value of 0 indicates that the manager's highest level of education is lower than undergraduate; they do not have any specific knowledge of laws and regulations and do not have relevant prior working experience. Meanwhile, the value of 3 indicates that managers have sufficient expertise and knowledge regarding those three aforementioned aspects.[3]

3.3. Measuring local business environment quality

In our study, we measure the local business environment quality using the Provincial Competitiveness Index (PCI). The PCI was designed to measure and rank the capacity of provincial governments to develop business-friendly regulatory environments for private sector development based on the following criteria: (1) low entry costs for new business; (2) easy access to land and security of business premises; (3) transparency in a business environment and equal access to business information; (4) minimal informal payments in exchange for public services; (5) less time spent on performing bureaucratic procedures and inspections; (6) limits in priorities and privileges given to state-owned, foreign or connected firms which might undermine private business activities; (7) proactivity and creativeness of provincial leadership in addressing the enterprises' problems; (8) the quality of business support services; (9) sound labour training policies; and (10) the ability of the legal and judicial system to settle disputes fairly and effectively.

The indices range from 0 to 100, with a higher score indicating a higher quality of local business environment. This provides a comparable measure of local business environment quality across provinces and has been widely used in previous empirical studies (Nguyen & Van Dijk, 2012; Bai et al., 2019; Nam & Tram, 2021; Vu & Nguyen, 2021). Given its high skewness, we use the natural logarithm of the PCI score to measure the local business environment.

Figure 1 presents the graph which tracks the changes of the PCI scores from 2005 to 2015 in the nine provinces examined in our study (Hanoi, Hai Phong, Ho Chi Minh City, Phu Tho, Nghe An, Quang Nam, Khanh Hoa, Lam Dong and Long An). The thick black line demonstrates the average value of the PCI scores.

3.4. Data and sample overview

This study utilizes two datasets. The first is the longitudinal data retrieved from the surveys of SMEs in Vietnam. The surveys were administered by the UNU-WIDER in cooperation with the Central Institute for Economic Management (CIEM), the Institute of Labour Science and Social Affairs (ILSSA) and the University of Copenhagen. The first round of the survey was conducted in 2005. In this survey, 2821 SMEs were selected from nine (out of 63) provinces in Vietnam. The sampling of provinces was stratified by regions and sub-regions of the country, by city versus rural, inland versus internationally bordered, and more importantly, by the variance in socio-economic conditions and the quality of the local business environment. Subsequently, five more biennial waves of

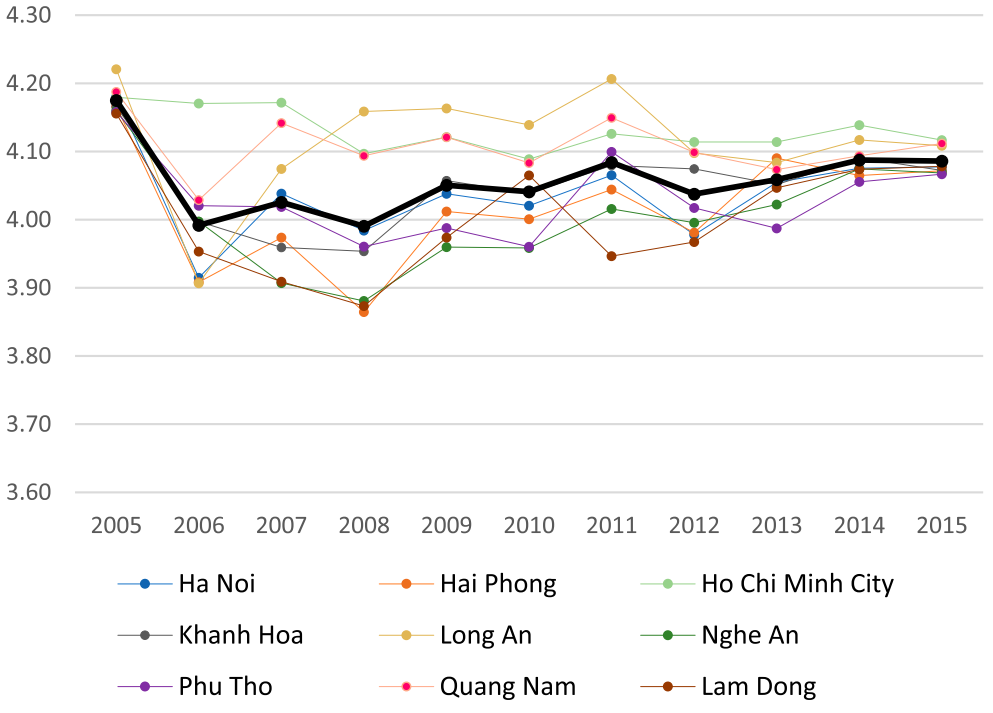

Figure 1. The evolution of PCI scores overtime (in natural logarithms).

surveys were conducted between 2007 and 2015. Because a number of SMEs ceased operating between surveys, additional SMEs were randomly selected and added to the survey to make a sample of roughly equally sized SMEs in each round. In terms of data coverage, this dataset contains several key parts of financial information of the SMEs, including firm size, profitability, leverage and, in particular, tax corruption. It also contains detailed information on the expertise of each of the managers, including formal education, knowledge of various laws, and previous working experience.

The second dataset is from Vietnam's annual Provincial Competitiveness Index (PCI) surveys, which are conducted by the Vietnam Chamber of Commerce and Industry (VCCI) and the United States Agency for International Development (USAID). Constructed from the most meticulously and elaborately conducted annual enterprise survey data in Vietnam, the PCI gathers the perspectives of firms operating across the country about the local business environment of the provinces where they are incorporated. A wide range of local business environment features is assessed, including the quality of economic governance, the ease and friendliness of the business environment and administrative reform efforts of provincial governments in Vietnam. The PCI data has been a useful source of information for both academic researchers and policy makers to identify bottlenecks in economic governance and to conduct governance reforms most effectively.

We combine the first and second sources of data to create a unique panel dataset that allows us to evaluate the impact of manager expertise on the participation of firms in tax corruption and how such behaviour change due to variations in the local business

environment quality. After winsorising all continuous variables at 1st and 99th levels, our final data set consists of 14,673 firm-year observations covering 4939 Vietnamese SMEs during the period from 2005 to 2015.

Table 2 provides descriptive statistics of our main regression variables. On average, roughly 9% of firms are involved in bribery when dealing with taxes and taxation, with an average bribe payment (in natural log of millions of Vietnamese Dong) of 0.703. In addition, firm managers in our sample appear to have moderate levels of expertise as the mean value of *Manager Expertise* is 1.57.

Table 3 presents a correlation matrix of the main explanatory variables. This table shows that all correlations are much smaller than 0.50, indicating no serious multicollinearity among our explanatory variables.

4. Empirical results

4.1. Initial evidence

Before evaluating how manager expertise shapes their tax corruption behaviour under different business environments, we test the impact of manager expertise on corruption behaviour and the impact of the local business environment on the tax corruption practice of firms separately. Sections 4.1.1 and 4.1.2 provide the results and discussions of our preliminary analyses.

4.1.1. Manager expertise and tax corruption

Table 4 shows the estimated results of the regressions examining the effect of manager expertise on tax corruption. Columns 1–3 show the results of the linear probability models estimating the likelihood of firms engaging in tax corruption. It is worth noting that, despite the binary nature of the dependent variable (e.g. *Bribery Probability*), we estimate our model using the Ordinary Least Squares (OLS) estimator. This is because we have a large number of fixed effects along several dimensions, meaning that using maximum likelihood estimators (i.e. logit or probit) could produce an incidental parameters problem (Lancaster, 2000).[4] Meanwhile, columns 4–6 present the results of the OLS models examining the impact of manager expertise on the amount of tax corruption (e.g. *Bribery Amount*).

Table 2. Summary statistics.

Variable	Obs.	Mean	Std.	Min	p25	p50	p75	Max
Bribery	14,673	0.092	0.289	0.000	0.000	0.000	0.000	1.000
Bribery amount	14,673	0.703	2.259	0.000	0.000	0.000	0.000	13.456
Manager expertise	14,673	1.573	0.891	0.000	1.000	2.000	2.000	3.000
Business environment	14,673	4.030	0.096	3.707	3.978	4.069	4.097	4.159
Firm age	14,673	2.279	0.824	0.000	1.792	2.398	2.833	3.989
Firm size	14,673	13.548	1.838	9.616	12.155	13.611	14.891	17.804
ROA	14,673	2.009	2.476	0.046	0.455	1.071	2.494	12.581
Leverage	14,673	0.180	0.374	0.000	0.000	0.022	0.191	2.375
Export	14,673	0.062	0.241	0.000	0.000	0.000	0.000	1.000
Professional staff	14,673	0.034	0.068	0.000	0.000	0.000	0.036	0.333
Business association	14,673	0.090	0.286	0.000	0.000	0.000	0.000	1.000
Manager gender	14,673	0.642	0.479	0.000	0.000	1.000	1.000	1.000
Manager age	14,673	3.770	0.241	3.178	3.611	3.784	3.951	4.277

Table 3. Correlation matrix.

		1	2	3	4	5	6	7	8	9	10	11	VIF
1	*Manager expertise*	1.000											1.34
2	*Business environment*	0.127	1.000										1.10
3	*Firm age*	−0.167	−0.022	1.000									1.19
4	*Firm size*	0.407	0.129	−0.090	1.000								1.89
5	*ROA*	−0.011	0.144	−0.004	−0.426	1.000							1.65
6	*Leverage*	0.085	0.157	−0.009	−0.130	0.462	1.000						1.31
7	*Export*	0.191	0.061	−0.050	0.271	0.029	0.058	1.000					1.14
8	*Professional staff*	0.358	0.071	−0.168	0.396	−0.034	0.099	0.160	1.000				1.32
9	*Business association*	0.155	−0.056	0.028	0.230	−0.040	0.058	0.203	0.179	1.000			1.12
10	*Manager gender*	0.008	−0.101	0.024	−0.048	−0.008	−0.018	−0.037	−0.072	0.000	1.000		1.18
11	*Manager age*	−0.050	−0.024	0.352	−0.064	−0.049	−0.032	−0.055	−0.104	0.039	0.152	1.000	1.04

Table 4. Manager expertise and tax corruption.

	Bribery probability (1)	Bribery probability (2)	Bribery probability (3)	Bribery amount (4)	Bribery amount (5)	Bribery amount (6)
Manager expertise	0.013***	0.014***	0.014***	0.103***	0.112***	0.111***
	(0.003)	(0.003)	(0.003)	(0.025)	(0.025)	(0.025)
Firm age	−0.011***	−0.008**	−0.008**	−0.080***	−0.059**	−0.061**
	(0.003)	(0.003)	(0.003)	(0.026)	(0.026)	(0.026)
Firm size	0.022***	0.021***	0.021***	0.198***	0.183***	0.182***
	(0.002)	(0.002)	(0.002)	(0.017)	(0.015)	(0.015)
ROA	0.002*	0.002	0.002	0.023**	0.018**	0.016*
	(0.001)	(0.001)	(0.001)	(0.009)	(0.009)	(0.009)
Leverage	0.010	0.004	0.002	0.084	0.050	0.032
	(0.008)	(0.008)	(0.008)	(0.064)	(0.064)	(0.065)
Export	−0.028**	−0.031**	−0.030**	−0.158	−0.174	−0.170
	(0.013)	(0.013)	(0.014)	(0.113)	(0.117)	(0.119)
Professional staff	0.183***	0.193***	0.194***	1.552***	1.633***	1.650***
	(0.049)	(0.051)	(0.050)	(0.394)	(0.405)	(0.404)
Business association	−0.028***	−0.024**	−0.022**	−0.213***	−0.185**	−0.170**
	(0.010)	(0.010)	(0.010)	(0.081)	(0.081)	(0.081)
Manager gender	−0.004	−0.003	−0.003	−0.035	−0.028	−0.024
	(0.005)	(0.005)	(0.006)	(0.041)	(0.043)	(0.043)
Manager age	−0.013	−0.007	−0.006	−0.138	−0.107	−0.094
	(0.011)	(0.011)	(0.011)	(0.088)	(0.089)	(0.089)
Province FEs	YES	NO	NO	YES	NO	NO
Industry FEs	NO	YES	NO	NO	YES	NO
Year Fes	YES	YES	NO	YES	YES	NO
Industry-year FEs	NO	NO	YES	NO	NO	YES
R-square	0.042	0.035	0.045	0.046	0.042	0.052
Observations	14,673	14,673	14,673	14,673	14,673	14,673
Number of firms	4,939	4,939	4,939	4,939	4,939	4,939

Note: Constants are excluded for brevity. Robust standard errors are in parentheses. ***, **, * represent statistical significance at 1%, 5%, and 10% levels, respectively.

We perform various types of fixed effects throughout our models. Specifically, Columns 1 and 4 use year fixed effects and province fixed effects to control for time-invariant and province-specific factors. In Columns 2 and 5, we substitute province fixed effects with industry fixed effects to control for unobservable industry-specific factors that may influence the tax corruption behaviour of SMEs. In Columns 3 and 6, we employ industry-year fixed effects to capture the unobserved factors that do not vary across firms within a given industry and year.

As can be seen from the first three columns, the estimated coefficients on *Manager Expertise* are always positive and statistically significant. This suggests that more able managers, that is, those who are better educated, have a greater knowledge of the law and regulations, and have sufficient working experience, are more likely to engage in tax corruption. The feasible explanation is that highly educated managers can utilise their greater cognitive skills and awareness capabilities to reduce the uncertainties associated with tax bribery. Meanwhile, their understanding of the law (which includes tax law) allows firm managers to identify loopholes more easily so that they can explore ample bribery opportunities in taxation. In a similar vein, more experienced managers can have a better understanding about the ways of doing business with local governments and establish a network of trustworthy bribe-takers. This subsequently allows

firms to mitigate the risk of not receiving what they 'paid for' and therefore, to benefit from corruption. These findings lend support to our proposition that more able managers have higher expected benefits from tax corruption due to their ability to identify the tax evasion opportunities as well as the loopholes in existing laws and regulations.

Columns 4–6 present the results of the models to examine the impact of manager expertise on the amount of tax corruption. We find that SMEs with higher levels of managerial expertise pay more bribery to deal with taxation, as indicated by the positive and significant coefficient of *Manager Expertise* throughout all the columns. This corroborates the provision that more able managers can make use of their knowledge and capabilities to be more eagerly involved in tax corruption activities

Additional findings from Table 4 are that larger firms, firms with less operating experience (indicated by smaller firm age), and firms having a more professional staff are more likely to commit tax corruption and pay more tax bribes to public tax officers. These findings are in line with several previous studies (i.e. Chavis, 2013). On the other hand, being a member of a business association reduces both the probability and the amount of tax bribery, probably due to the concern about the firm's reputation among its business partners. It is also possible that firms can make use of their business connections to resolve their taxation problems, rather than resorting to corruption. We also find some evidence that more profitable firms engage more in tax corruption, whereas firms that have export activities are less involved in tax corruption.

4.1.2. Local business environment and tax corruption

Previous literature suggests that the quality of the business environment may influence firm incentives to become involved in corruption. Specifically, macro-level institutional constraints, such as market entry barriers (Broadman & Recanatini, 2001), lack of market competition regulations (Ades & Di Tella, 1999), lack of accountability (D'Souza & Kaufmann, 2013), and rigid trade and investment policies (Gerring & Thacker, 2005) are perceived as a prolific breeding ground for corruption. To compensate for a bad-governance and low-quality local business environment, firms may resort to corruption in order to circumvent cumbersome and rigid regulations (Dutta & Sobel, 2016; Bologna & Ross, 2015), and proceed to obtain government contracts and policy incentives (Mironov, 2015). Therefore, we would need to investigate how the local business environment influences SMEs' tax corruption practices in Vietnam.

Table 5 provides the results of the regressions examining the effect of the quality of the local business environment on tax corruption by SMEs. We sequentially estimate the model using province and year fixed effects (columns 1 and 4), industry and year fixed effects (columns 2 and 5), and industry-year fixed effects (columns 3 and 6). Again, columns 1–3 show the results of the linear probability model to estimate the probability of firms engaging in tax corruption, whereas columns 4–6 report the result of the OLS models which examine the impact of a local business environment on the amount of informal payments which firms made to corrupt tax officials.

As can be seen in Table 5, the estimated coefficients on *Business Environment* are negative and statistically significant across all the models, indicating that local business environment quality and tax corruption are inversely associated. In other words, when the quality of the local business environment increases, firms are less eager to become involved in tax corruption. Our findings are in line with the previous studies, such as in

Table 5. Local business environment and tax corruption.

	Bribery probability (1)	Bribery probability (2)	Bribery probability (3)	Bribery amount (4)	Bribery amount (5)	Bribery amount (6)
Business environment	−0.131**	−0.104***	−0.097***	−0.957**	−0.724***	−0.651***
	(0.061)	(0.030)	(0.031)	(0.462)	(0.227)	(0.237)
Firm age	−0.013***	−0.010***	−0.010***	−0.092***	−0.077***	−0.078***
	(0.003)	(0.003)	(0.003)	(0.026)	(0.026)	(0.026)
Firm size	0.024***	0.024***	0.023***	0.215***	0.206***	0.204***
	(0.002)	(0.002)	(0.002)	(0.016)	(0.014)	(0.014)
ROA	0.003**	0.003**	0.002*	0.027***	0.024***	0.021**
	(0.001)	(0.001)	(0.001)	(0.009)	(0.009)	(0.009)
Leverage	0.011	0.006	0.003	0.095	0.063	0.044
	(0.008)	(0.008)	(0.008)	(0.065)	(0.064)	(0.065)
Export	−0.026**	−0.026**	−0.026*	−0.140	−0.141	−0.138
	(0.013)	(0.013)	(0.014)	(0.113)	(0.117)	(0.118)
Professional staff	0.213***	0.222***	0.223***	1.790***	1.863***	1.881***
	(0.049)	(0.050)	(0.050)	(0.391)	(0.402)	(0.401)
Business association	−0.026***	−0.025***	−0.023**	−0.201**	−0.191**	−0.175**
	(0.010)	(0.010)	(0.010)	(0.081)	(0.081)	(0.082)
Manager gender	−0.003	−0.004	−0.003	−0.025	−0.029	−0.024
	(0.005)	(0.005)	(0.006)	(0.041)	(0.043)	(0.043)
Manager age	−0.011	−0.004	−0.003	−0.129	−0.085	−0.073
	(0.011)	(0.011)	(0.011)	(0.088)	(0.088)	(0.089)
Province FEs	YES	NO	NO	YES	NO	NO
Industry FEs	NO	YES	NO	NO	YES	NO
Year Fes	YES	YES	NO	YES	YES	NO
Industry-year FEs	NO	NO	YES	NO	NO	YES
R^2	0.041	0.035	0.044	0.045	0.041	0.051
Observations	14,673	14,673	14,673	14,673	14,673	14,673
Number of firms	4939	4939	4939	4939	4939	4939

Note: Constants are excluded for brevity. Robust standard errors are in parentheses. ***, **, * represent statistical significance at 1%, 5%, and 10% levels, respectively.

the literature about the effects of the institutional environment on corruption (Bjørnskov, 2011). The feasible explanation is that, when the quality of local business environment is high, the probability of a corrupt deal being exposed is also greater. In this context, both firms and corrupt officials are subject to a higher risk of being punished by law, and therefore, they have less of an incentive to engage in corrupt activities.

4.2. Manager expertise, local business environment and tax corruption

Table 6 shows the estimated results of the main model (3) examining the impact of manager expertise and the quality of the local business environment on tax corruption of SMEs. As in the previous sections, we assess two aspects of tax corruption: (i) the probability of engaging in tax corruption; and (ii) the amount of tax corruption.

The key independent variable of interest is the interaction terms between *Manager Expertise* and local business environment quality (i.e. *Business Environment*). A positive (negative) coefficient on *Manager Expertise* × *Business Environment* would indicate that, as the quality of the local business environment improve, more able managers are more (less) eager to engage in tax corruption.

We follow the procedure established in the prior sections and estimate model (1) using different types of fixed effects. Specifically, columns 1 and 4 show the results of the model

using province and year fixed effects. Columns 2 and 5 report the results using industry and year fixed effects, while columns 3 and 6 provide the results of the model using industry-year fixed effects.

As can be seen from the first three columns, the estimated coefficients on *Manager Expertise* × *Business Environment* are always negative and significant, showing that increasing manager expertise in areas characterized as having better business environments have diminishing impacts on the likelihood of engaging in tax corruption. This finding provides support to the proposition that a higher quality local business environment moderates the effects of managerial expertise on tax corruption. Arguably the improved local business environment is associated with better law enforcement and efficient court systems, leading to the risk – and cost – of misconduct incidents being detected and punished being higher for both managers and corrupt tax officials. At the same time, increased business environment quality also implies less rigid and cumbersome regulations, which in turn makes tax bribes and corruption unnecessary (Dutta & Sobel, 2016; Bologna & Ross, 2015). In such an environment, the expected benefit from tax corruption is diminished and more able managers can directly utilize their expertise

Table 6. Manager expertise, local business environment and tax corruption.

	Bribery probability (1)	Bribery probability (2)	Bribery probability (3)	Bribery amount (4)	Bribery amount (5)	Bribery amount (6)
Manager expertise	0.296**	0.455***	0.463***	2.164**	3.279***	3.451***
	(0.117)	(0.111)	(0.112)	(0.961)	(0.899)	(0.904)
Business environment	−0.023	0.048	0.058	−0.170	0.364	0.505
	(0.069)	(0.041)	(0.042)	(0.535)	(0.308)	(0.316)
Manager expertise × *Business environment*	−0.070**	−0.109***	−0.111***	−0.512**	−0.786***	−0.829***
	(0.029)	(0.028)	(0.028)	(0.239)	(0.224)	(0.225)
Firm age	−0.011***	−0.008**	−0.008**	−0.078***	−0.062**	−0.064**
	(0.003)	(0.003)	(0.003)	(0.026)	(0.026)	(0.026)
Firm size	0.022***	0.021***	0.021***	0.195***	0.187***	0.185***
	(0.002)	(0.002)	(0.002)	(0.017)	(0.015)	(0.015)
ROA	0.002*	0.002*	0.002	0.022**	0.019**	0.017*
	(0.001)	(0.001)	(0.001)	(0.009)	(0.009)	(0.009)
Leverage	0.010	0.005	0.002	0.086	0.056	0.036
	(0.008)	(0.008)	(0.008)	(0.064)	(0.064)	(0.065)
Export	−0.027**	−0.028**	−0.027**	−0.150	−0.153	−0.149
	(0.013)	(0.013)	(0.013)	(0.113)	(0.117)	(0.118)
Professional staff	0.186***	0.192***	0.193***	1.572***	1.629***	1.646***
	(0.049)	(0.050)	(0.050)	(0.394)	(0.403)	(0.402)
Business association	−0.028***	−0.028***	−0.026***	−0.213***	−0.213***	−0.196**
	(0.010)	(0.010)	(0.010)	(0.081)	(0.081)	(0.082)
Manager gender	−0.004	−0.005	−0.004	−0.036	−0.037	−0.033
	(0.005)	(0.005)	(0.006)	(0.041)	(0.043)	(0.043)
Manager age	−0.015	−0.010	−0.009	−0.154*	−0.129	−0.118
	(0.011)	(0.011)	(0.011)	(0.088)	(0.089)	(0.089)
Province FEs	YES	NO	NO	YES	NO	NO
Industry FEs	NO	YES	NO	NO	YES	NO
Year FEs	YES	YES	NO	YES	YES	NO
Industry-year FEs	NO	NO	YES	NO	NO	YES
R^2	0.042	0.037	0.046	0.046	0.044	0.053
Observations	14,673	14,673	14,673	14,673	14,673	14,673
Number of firms	4939	4939	4939	4939	4939	4939

Note: Constants are excluded for brevity. Robust standard errors are in parentheses. ***, **, * represent statistical significance at 1%, 5%, and 10% levels, respectively.

in value-enhancing business activities rather than colluding with corrupt tax officials to obtain preferential treatments.

Likewise, we also find that the estimated coefficients on *Manager Expertise* × *Business Environment* are also positive and statistically significant across columns 4–6 of the bribery amount models. Therefore, this reinforces our finding that, as the local business environment quality improves, more able managers engage less in tax corruption. Figure 2 graphically illustrates this interaction effect.

5. Additional analyses

5.1. Different components of manager expertise

In this section, we attempt to shed light on which aspect of managerial expertise affect corrupt tax behaviour. To do so, we break down our *Manager Expertise* measure into its components, capturing the (i) general knowledge acquired through formal education; (ii) specific/informal knowledge of law; and (iii) specific/informal knowledge acquired through a manager's working experience.

We measure the general knowledge acquired from formal education of managers as a dummy variable (*Formal Education*), taking the value of 1 if managers had obtained a university degree or above and 0 otherwise. We also measure a manager's specific knowledge of laws as a dummy variable (*Knowledge of Law*). *Knowledge of Law* equals 1 if the manager responds as having knowledge of at least one of the following: enterprise law, cooperative law, labour code, customary law, insurance law, tax law, environment law, land law, investment law, social insurance law and gender equality law; and 0 otherwise. Finally, we measure the prior working experience of a manager as a dummy variable (*Experience*), taking the value of 1 if the manager has worked with similar products/services before and 0 otherwise. We then augment the baseline model (3) by sequentially replacing the *Manager Expertise* variable with *Formal Education*, *Knowledge of Law* and *Experience* dummies, and re-estimate the model accordingly. The results are presented in Table 7.

As can be seen from Table 7, the estimated coefficients on *Manager Expertise* are not statistically significant in Columns 1 and 2, but positive and significant in Columns 3 and 4 and 5 and 6. This suggests that while a manager's educational level does not exert significant impact on tax corruption, specific knowledge of laws and prior working experience are significantly associated with more tax corruption, both in terms of the probability and amount of tax corruption.

Overall, our results corroborate the strand of empirical works suggesting that more knowledgeable managers, especially those with tax knowledge, might not necessarily exhibit better tax compliance (Maseko, 2014; Bird, 2013). Although tax knowledge allows managers to be aware of what is stated in the laws and expected sanctions (Newman et al., 2018), our results imply that a good knowledge of laws and regulations also allows firm managers to spot any non-compliance opportunities and make use of these opportunities accordingly. These findings are also in line with extant literature, which suggests that tax corruption practices require specific knowledge on tax-related issues and informal knowledge of dealing with public tax officers accumulated through working experience. That kind of knowledge and experience can hardly be acquired through formal education. In addition, education may be associated with

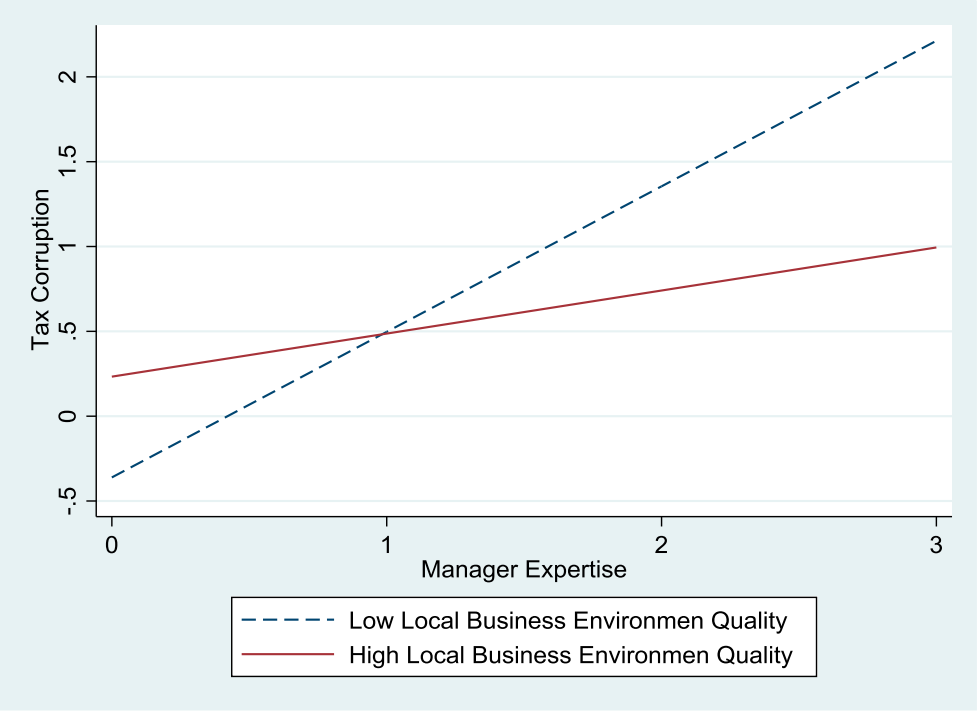

Figure 2. Moderating effect of local business environment.

moral development and the preference for using formal business strategies (Karami et al., 2006; Tu, 2012), which restrains managers from acting corruptly in taxation matters.

5.2. Different components of manager expertise, local business environment and tax corruption

Having pointed out that different aspects of managerial expertise may have different influences on tax corruption, we now extend our analysis and evaluate how a manager's

Table 7. Different components of manager expertise and tax corruption.

	Education		Knowledge of law		Experience	
	Bribery probability (1)	Bribery amount (2)	Bribery probability (3)	Bribery amount (4)	Bribery probability (5)	Bribery amount (6)
Manager expertise	0.008	0.103		0.251***	0.011**	0.090**
	(0.008)	(0.063)	(0.005)	(0.034)	(0.005)	(0.040)
Other controls	YES	YES	YES	YES	YES	YES
Industry-year FEs	YES	YES	YES	YES	YES	YES
R^2	0.043	0.050	0.045	0.052	0.044	0.051
Observations	14,673	14,673	14,673	14,673	14,673	14,673
Number of firms	4939	4939	4939	4939	4939	4939

Note: Constants are excluded for brevity. Robust standard errors are in parentheses. ***, **, * represent statistical significance at 1%, 5%, and 10% levels, respectively.

Table 8. Different components of manager expertise, local business environment and tax corruption.

	Education		Knowledge of law		Experience	
	Bribery probability (1)	Bribery amount (2)	Bribery probability (3)	Bribery amount (4)	Bribery probability (5)	Bribery amount (6)
Manager expertise	0.524*	4.387*	0.472***	2.834**	0.694***	5.634***
	(0.307)	(2.525)	(0.164)	(1.215)	(0.194)	(1.503)
Business environment	−0.073**	−0.450*	−0.021	−0.201	−0.023	−0.046
	(0.032)	(0.234)	(0.035)	(0.258)	(0.034)	(0.251)
Manager expertise × *Business environment*	−0.128*	−1.060*	−0.108***	−0.642**	−0.169***	−1.375***
	(0.076)	(0.624)	(0.041)	(0.305)	(0.048)	(0.374)
Industry-year FEs	YES	YES	YES	YES	YES	YES
R^2	0.044	0.051	0.046	0.052	0.045	0.052
Observations	14,673	14,673	14,673	14,673	14,673	14,673
Number of firms	4939	4939	4939	4939	4939	4939

formal education, knowledge of law and working experience interact with the local business environment and affect managers' tax corruption behaviour.

To do so, we slightly augment the model presented in Section 5.1 and sequentially interact each of the measures of manager expertise (i.e. *Formal Education*, *Knowledge of Law* and *Experience*) with *Business Environment*. We adopt procedures similar to those employed in other sections and assess tax corruption both in terms of the probability of engaging in tax corruption and the amount of tax corruption. The regression results of the model to examine how different aspects of managerial expertise affect tax corruption under different business environment are reported in Table 8.

As can be seen from Table 8, the estimated coefficients on *Manager Expertise* × *Business Environment* are always negative and statistically significant across all the columns (albeit only marginally significant in the first two columns when manager expertise is assessed in terms of the formal education of a manager). Thus, these results reinforce our findings in Section 4.2 that, when the quality of the local business environment improves, managers with a higher level of expertise are less eager to engage in tax corruption.

6. Conclusion

While tax evasion and corruption are rampant among firms in transitional countries, little is known about how knowledgeable managers of these firms behave in different local business contexts. By using a longitudinal dataset from biennial surveys of SMEs in the transition economy of Vietnam over the period from 2005 to 2015, this study shows that the tax corruption behaviour of a firm's managers depends on the managers' expertise, as well as the quality of the local business environment in which the firms operate. Specifically, we find that more able managers are more likely to be involved in tax corruption and are more willing to pay a higher amount of bribes to the public tax officers. This is particularly the case for firms managed by managers having superior knowledge of laws and regulations and who have more working experience. However, we also find that an improved local business environment would lead to lower tax corruption practices.

One of the main contributions of this paper rests on the investigation of how the business environment can shape the tax corruption behaviour of managers with

different levels of expertise. We show in detail that, as the quality of local business environment improves, more able managers tend to engage less in tax corruption and make fewer payments to corrupt tax officials. The feasible explanation is that in a business environment with clearly codified and consistently implemented laws, low regulatory burden and strengthened rule of law, the opportunities and incentives for managers to take advantage of their expertise to engage in tax bribery are lowered while the costs and risks associated with bribery activities are heightened.

Overall, this study contributes to understanding more about tax corruption practices of firms in the context of a transitional country like Vietnam. Our findings suggest that to reduce tax corruption, which is often conducted by more able managers, it is important both to address tax corruption problems directly and also to improve the quality of the local business environment. Enhanced and improved local business environments should be created side-by-side with other policies to fight against tax corruption.

We should acknowledge that this paper has a limitation arising from the potential endogeneity issue in our empirical analysis. Although we have used many strong fixed effects and controlled for various firm-specific characteristics, there can still be unobserved firm-level factors that are simultaneously correlated with manager expertise and the firms' tax corruption behaviour. One possible way is to deal with this is to use an instrumental variable (IV) approach (i.e. IV-2SLS). Unfortunately, finding appropriate IVs for manager expertise is very difficult and a weak instrument that may cause further bias in the estimations (Hahn & Hausman, 2003). Therefore, the results reported in this paper should be considered somewhat exploratory, and future studies would be well advised to find ways to more properly address the endogeneity concern.

Notes

1. To ensure the robustness of the result, we have also re-estimated the model using the natural logarithm of the amount of the bribe payment (without plus 1), and the ratio of bribe payment to total revenues as alternative measures of *Bribery Amount*. The results remain largely unchanged and are available upon request.
2. In our study, we do not distingue between an owner and manager of an SMEs. Most of prior entrepreneurship or small-business management studies often use terms 'managers', 'owners' and 'owner-managers' interchangeably. This is because, unlike in large firms where managers are often hired by shareholders to run the business, in SMEs, their owners often take the dual role as the managers (Kim, 2021; Nguyen et al., 2020). Jennings and Beaver (1995) also posit that owners play key roles in the management process of small enterprises by directly influencing the firms' operations and activities. In the case of Vietnam, Nguyen (2021) illustrates that most SMEs still largely rely on their owner-managers' personal wealth to make investments.
3. In order to ensure that the three aforementioned components are consistent in terms of indicating manager expertise, we follow the previous literature and conduct a Cronbach's alpha test (Cortina, 1993). The value of the test result is supposed to fall within the range from 0.7 to 0.8. Our test result demonstrates $\alpha = 0.762$, indicating a high level of internal consistency among sub-indicators. To ensure the robustness of our result, we also re-estimate the baseline model using an alternative measure of managerial expertise. Arguably, the managers' specific knowledge of laws can be more directly related to their tax compliance behaviours and the incentives to engage in tax corruption rather than education or working experience.

Thus, we construct a composite index on the manager's knowledge of various laws and government regulations and consider it as an alternative measure of managerial expertise. As discussed, managers were asked to characterise their knowledge about various laws and government regulations. Based on this information, for each type of law, we create a dummy variable equal to 1 if the manager indicates that they have a good knowledge of that specific law. We then construct a composite index *Law Knowledge* as the sum of all of these dummy variables. Thus, the *Law Knowledge* index has a value ranging from 0 to 11. A value of 0 indicates that the manager does not have any knowledge of the laws and regulations, while a higher value indicates that the manager does have a good knowledge of a higher number of laws and government regulations. Overall, the results are largely unchanged and available upon request.

4. To ensure the robustness of our results, we also re-estimate the model using logit and probit models. The results are qualitatively unchanged. For the sake of saving space, these results are not reported, although they are available upon request.

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Are we there yet? Intergenerational mobility and economic assimilation of second-generation immigrants in Estonia

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ABSTRACT

This study investigates the role of intergenerational mobility in explaining the native-immigrant income gap in Estonia. A rich registry dataset on yearly earnings and different background characteristics for the period of 2007–2017 is used. We find that an increase of 1 percentile in parent income rank is associated with on average 0.2 percentile increase in child income rank for both natives and second-generation immigrants. Results from a detailed Blinder-Oaxaca decomposition indicate that up to 21% of the gap between income ranks of second-generation immigrants and natives is related to differences in parental background. Once we control for education, family, residence and industry related choices, differences in the parental income rank account for around 8% of the overall gap. The results indicate that although the intergenerational income mobility is relatively high in Estonia both for natives and children of foreign-born, the native-immigrant earnings gap has not decreased for the second generation.

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1. Introduction

The inferior labour market performance and consequent lower earnings of the first generation of immigrants compared to their native counterparts have long been documented in Europe (e.g. Beyer, 2016; Chiswick, 1980; Hammarstedt, 2003). However, in the long-term perspective of costs and benefits of migration, it is the labour market integration of the next generation that matters. If the first generation of immigrants are at a disadvantage in the host country's labour market and the level of intergenerational mobility is low, then the disadvantages are likely to persist into the next generation. This study investigates the level of intergenerational mobility of immigrants and the role of parental background in explaining the earnings gap between natives and second-generation immigrants in Estonia.

The foreign-born and mainly Russian-speaking community in Estonia is shown to have lower labour market outcomes than natives (Leping & Toomet, 2008). The gap in earnings and in entering the employment exists also for the younger generation of the Russian-

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speaking minority (Leping & Toomet, 2008; Lindemann, 2014). As at least a fifth of the economic advantages and disadvantages are shown to be carried on from parents to their children in Western Europe and Scandinavia (see Corak, 2006 for an overview), we will expect that in Estonia the gap in earnings between second-generation immigrants and their native peers can be partly explained by the economic situation of their parents.

There are different reasons why economic advantages or disadvantages persist from one generation to the next, restricting intergenerational mobility. Becker and Tomes (1979, 1986) develop theoretical models explaining how children's economic outcomes depend on what resources their families have available to invest in their human and non-human capital. Besides investments in the child, parents can also pass on other endowments to the child, such as genetically determined characteristics, family reputation, connections, knowledge, skills, goals, etc. The inheritability of these endowments and the propensity to invest in one's children affect the degree of intergenerational mobility. This approach is further developed by Solon (2004), adapting it so as to better facilitate international comparisons of mobility as well as its development over time.

Empirical studies have confirmed the importance of family background to economic attainment. One channel of family influence is parents' impact on the educational attainment of the child. For example, Landersø and Heckman (2017) find that although intergenerational mobility is higher in Denmark than in the US, it is largely due to the country's redistributive and wage-compressing policies, while the effect of family on educational attainment remains strong – educational mobility in the two countries is roughly equal despite the very different cost structures in the provision of education. This indicates that differences in parental financial resources for human capital investment is not the only factor in the intergenerational transmission of educational attainment. In addition, one must also consider differences in parental engagement – a number of studies have found that time spent on parenting activities in disadvantaged families is lower than in advantaged families (Guryan et al., 2008; Kalil et al., 2012; Mayer et al., 2019). Thus, one source of persistence of economic disadvantage from one generation to the next can be low parental endowments in human capital, resulting in their children having similarly low endowments.

At the same time, the income level of the first generation of immigrants might not reflect their whole level of ability, as they often face difficulties in the host country's labour market due to lack of language skills or other country-specific human capital (Aydemir et al., 2009). If these challenges are less pronounced for the second generation of immigrants and the transmission of genetic ability is high, then intergenerational mobility might be higher among immigrants than among native population.

In addition to the inheritability of cognitive and human capital endowments, it is also important how these endowments are valued in the labour market. For example, if returns to education are high and parents with higher human capital endowments pass on more investment in human capital (as well as such characteristics as values and goals related to education), this could lead to less generational mobility (Corak, 2013). If the human capital endowments of immigrant and native parents differ systematically, then this could result in different degrees of intergenerational mobility. In addition, differences in cultural values could lead to parental investments in the child's human capital to differ even for the same level of parental human capital.

Moreover, returns to education in the labour market could be different for immigrants and natives, leading to differences in parents' incentives to invest in their children's human capital. Indeed, Leping and Toomet (2008) find that returns to education are lower for minority males than for ethnic Estonian males, while Ridala and Toomet (2019) find that ethnic Russian men's cognitive skills are undervalued in the labour market compared to that of Estonian men. There can be several different explanations for the differential valuation of ethnic groups' characteristics in the labour market – an obvious possibility is discrimination (which has been demonstrated to exist in Estonia by correspondence studies, e.g. Lõgina, 2013; Uudmäe, 2012). Other possible explanations include hiring through different contact networks, which leads to a segregation of employees to Russian- or Estonian-language dominated firms (Leping & Toomet, 2008), or the pervasive effect of different language skills – insufficient official language skills can be expected to affect returns to education and other skills as well. Whatever its causes, lower valuation of ethnic minorities' characteristics in the labour market can also be expected to lower their intergenerational economic mobility.

While the channel of inherited human capital endowment is important in intergenerational transmission of economic advantage, there are also others. Büchner et al. (2012) demonstrate using data from the Netherlands that the social capital of the neighbourhood and parents' cultural capital also play a role (although less important than that of cognitive skills and schooling). Other potential factors include the transmission of time preferences, which could affect economic behaviour: Brenoe and Epper (2019) demonstrate substantial intergenerational transmission of patience, moderated by parenting values (authoritarian vs permissive parenting styles). Kreiner et al. (2020) find that financial behaviour is to some extent inherited – the propensity to default on a loan is higher for people whose parents have a history of defaulting, even controlling for income and other important variables. Intergenerational transmission has also been demonstrated for portfolio choice (Knüpfer et al., 2017) and financial literacy (Brown et al., 2018).

This study asks two questions. First, how much of the earnings advantage or disadvantage is carried on from foreign-born and native parents to their children? Second, to what extent does parental background explain the difference in the earnings of these two groups? By answering these questions, the paper contributes to the literature in two main ways.

Firstly, although the labour market situation of the children of immigrants and how it relates to that of their parents have been investigated to an extent in the US (Borjas, 1992, 1993), Canada (Aydemir et al., 2009) and Europe (see e.g. Nielsen et al., 2003; Schnitzlein, 2012 for Denmark, Hammarstedt, 2009; Hammarstedt & Palme, 2012 for Sweden, Hermansen, 2016 for Norway), much less is known about the situation of second-generation immigrants in the former Soviet Union. We contribute to the literature by investigating the intergenerational earnings mobility of immigrants in a country, where the share of immigrant population is substantial. In 2014, 21% of the working age population (15–64) in Estonia was native-born with at least one foreign-born parent, making it the country with the highest share of second-generation immigrants in the European Union (Eurostat, 2021, Table lfso_14pcobp). The situation of second-generation immigrants in Estonia is somewhat exceptional compared to Western European countries: their parents, who arrived in Estonia as labour migrants during the Soviet era in the

1970s and 1980s, were not negatively selected in terms of their education (Lindemann & Saar, 2012). However, after the collapse of Soviet Union, they have experienced difficulties in finding positions matching their level of education, leading to lower returns from educational attainment (Leping & Toomet, 2008).

As discussed above, there are different reasons, why intergenerational earnings mobility might differ between natives and immigrants. On the one hand, ability channel would predict intergenerational earnings mobility to be higher for the mainly Russian-speaking second generation (if we assume that their parents are working on positions not reflecting their ability). However, earlier studies have shown that second-generation immigrants in Estonia are more likely to experience educational downward mobility, resulting in their average education level being lower than among Estonians (see Lindemann & Saar, 2012; Oberdabernig & Schneebaum, 2017). Thus, the ability channel might not result in higher mobility for second-generation immigrants than natives in our sample.

On the other hand, it is possible that second-generation immigrants are restricted by some of the same challenges as their parents, namely insufficient official language skills and limited contact networks, limiting their ability to reach higher education and higher-paying positions.[1] Overall, this could lead immigrant population to have higher correlation between parents' and children's incomes (lower mobility) than natives.

Our second contribution results from investigating the role of parental background in explaining the native-immigrant income gap at the level of second generation. While the earlier studies have tried to explain the mean earnings differences between natives and immigrants by the differences in returns to education (Leping & Toomet, 2008), in cognitive skills (Ridala & Toomet, 2019), in official language skills (Lindemann, 2014; Toomet, 2011) and in the use of skills at work (Tverdostup & Paas, 2017), a significant proportion of the gap is still left unexplained. Parental education and occupation have been included to explain the education gap between Estonian and Russian youth (see Lindemann & Saar, 2012), however, to the best of our knowledge, parental income has not been in focus in earlier studies to explain the earnings gap between natives and immigrants in Estonia.

Earlier studies argue that the unexplained proportion of the gap could relate to social network segregation and hiring through different contact networks (e.g. Leping & Toomet, 2008). We argue that parental background may account for some of these network-specific effects as besides parental influence on human capital investments of the child, a proportion of social capital is also inherited from the parents (see e.g. Büchner et al., 2012). Social and ethnic networks shared by the different generations often results in the children of immigrants working in the same sectors as their parents (Kogan, 2007). The lack of proper contact networks would therefore lead both first-generation immigrants and their children at a disadvantage in the local labour market. Thus, we expect that parental background (manifested in earnings) will contribute to the explanation of the income rank gap even after controlling for the child's educational attainment and employment sector.

We estimate the level of relative mobility for children of native and foreign-born parents and use the Oaxaca–Blinder decomposition to explain the differences in the mean income rank of children from native and foreign households. We find that the level of intergenerational mobility in Estonia is comparable to that of the Nordics, with an increase of 1 percentile in the parent income rank being associated with a 0.2 percentile increase in the child income rank on average. The level of intergenerational mobility is

around the same magnitude for natives and for second-generation immigrants. As the income position is partly inherited from the parents, the differences in parental background explain 8% to 21% of the income rank gap between second-generation immigrants and natives. The results indicate that although intergenerational mobility is relatively high, the differences in earnings between natives and foreign-born do not decrease in their children's generation.

The rest of the paper is organized as follows. Section 2 describes the data, while Section 3 introduces the methodological approach. The results are presented and discussed in Section 4 and Section 5 concludes the paper.

2. Data

This study uses a dataset that includes (among other characteristics) information on age, gender, level of education, region of residence, country of birth and yearly earnings of all people residing in Estonia in the period 2007–2017. In order to create the dataset, the Estonian Population Register first selected all individuals who had been issued personal identification codes before 2017. To this sample of individuals, relevant data was then linked from registries of the Tax and Customs Board, the Ministry of Education and Research, the Police and Border Guard Board, the Unemployment Insurance Fund, the Health Insurance Fund and the Social Insurance Board.[2]

The data is from the time period 2007–2017. As the longitudinal component of the data covers only 11 years, it is not possible to observe the income of a child's parents at the time of their birth or early childhood, while retaining the ability to observe the income of the child in the later stages of his or her life. A solution used in this study is to focus on young people that have mostly completed their education and are entering the labour market (24–26 year olds in the year 2007). This allows us to look at their income 10 years after their labour market entry, when they are aged 34–36. This leaves sufficient time for potential inequalities to become apparent – based on the pseudo cohort data, 34–35 is roughly the age in the Estonian labour market at which the income relative to other age groups is the highest (Anspal et al., 2011).

This means that we observe the parental income not at the birth or early childhood of the child but when they are aged 24–26 instead. It is possible that the economic status of parents changes over that time. However, this change has some desirable characteristics. One might argue that for young parents (aged 20–25) the income at the time of their child's birth would be misleading as a proxy for the economic living conditions during the whole of childhood. People in their early twenties still participate in studies that may be rewarded with higher income in the future, but hinder full-time participation in the labour market at the time and, thus, result in a lower income during studies. It might be wise to look at parents' income at a more mature stage of their labour market experience.

Our focus is on the intergenerational economic mobility of individuals with native and with foreign-born parents. We construct a family type for each person based on the data available about the person's parents in the Estonian Population Register. There are six possible outcomes based on the birth country of parents and the availability of data (see Table 1). Altogether, in 2007, there were 58,244 persons in the age group 24–26. For 1736 persons in the age group 24–26 (in 2007) there is no information on their

Table 1. Sample size by family type and the child's age in 2007.

Family type	Age 24	Age 25	Age 26	Age 24–26
Birth country of parents not known	532	555	649	1736
1 foreign, 1 unknown	973	967	1009	2949
1 Estonian, 1 unknown	3014	3044	3078	9136
Parents were born abroad	2223	2044	2028	6295
1 Estonian, 1 from abroad	3033	2799	2676	8508
Parents were born in Estonia	10,275	9817	9528	29,620
Total	**20,050**	**19,226**	**18,968**	**58,244**

parents. For 12,085 persons, information on one of the parents is missing. The missing data on parents means that either there is no information on the parent at all or there is no information on their country of birth.

We are interested in the income position of the individuals who were 24–26 years old in 2007 (we refer to them as *children*) in two different earnings hierarchies. First, we find the earnings position of the child based on child's parents' income in 2007. We find parent income as a summed income of the mother and father of the child. Income is defined as a sum of pre-tax annual wages, income from self-employment and capital income (social welfare transfers are not included).[3] We then rank the parents relative to other parents of the children in the same birth cohort. As we are interested in the parent income rank among the whole population of parents, we include all pairs of parents irrespective of their country of birth in this ranking (parents from all six family types are included). Based on this ranking we calculate the income percentile and the income quintile of the parents for each child (we refer to these variables as *parent income rank* and *parent income quintile*). Among the dataset we have 9% of children whose summed parent income is zero, meaning that both mother and father are either unemployed or inactive. As ranking the parents is arbitrary in the first 9 percentiles (all of them have zero income), we opt for ranking them all in the middle percentile of this interval, meaning that these children are ranked as having parent income in the 5th percentile.[4]

Second, we calculate the income position of the children 10 years later, in 2017, based on their own income. Child income is defined similarly as for the parents, including pre-tax annual wages, income from self-employment and capital income.[5] The children are ranked based on their income relative to other children in the same birth cohort (similar to parents we include children from all six family types in this ranking). Again, we find the percentile and quintile in the income distribution for each child and refer to them as *child income rank* and *child income quintile*. Among the children, 9% are either unemployed or inactive having zero income. We use similar solution as for the parents, ranking them in the 5th income percentile.

Out of the 58,244 individuals who were aged 24–26 in 2007, 8323 (14.3%) were not in the dataset in 2017. This means that for these individuals the data provided by our source registers did not include any information on earned income, services used or benefits received in 2017. In all likelihood, most of them did not reside in Estonia in 2017.[6] As there is no information on their income, we will have to exclude them and focus on the remaining 49,921 observations.

As we are interested in estimating the intergenerational mobility by the birth country of parents in the following analysis, we focus on individuals for whom information on the country of birth is available for both of their parents. Thus, we exclude 11,320

observations, in which case information on one or both of the parents is missing.[7] This leaves us with 26,224 observations, where both of the parents are born in Estonia (we refer to them as *natives*), 5213 individuals, whose both parents are born abroad (we refer to them as *foreign households*) and 7164 observations, in which case one of the parents is born abroad and one is born in Estonia (we refer to them as *mixed households*).

The data sources and descriptions of variables included in the analysis are given in Table A1. Descriptive statistics for the variables included in the analysis are presented in Table A2 in Appendix. The descriptive statistics for our sample confirm earlier observations in the literature for the second-generation immigrants in Estonia. The children from foreign households have on average lower income rank and come from a family with on average lower income rank. They also have on average lower educational attainment than natives. The second-generation immigrants are more likely to live in capital region Harjumaa and minority-populated region Ida-Virumaa and more likely to work in less knowledge-intensive services and low-technology manufacturing than natives. The children from mixed families remain between natives and children from foreign families in terms of most descriptive statistics. The table also reports educational attainment of mother and father (not included in the subsequent analysis),[8] confirming that the first generation of immigrants were positively selected in terms of their education.

3. Methodology

To investigate the level at which economic advantages and disadvantage persist over generations, we first measure the level of relative intergenerational mobility. We follow the income percentile rank approach introduced by Chetty et al. (2014) and applied for different ethnic groups by Chetty et al. (2020), and calculate the income percentile rank of the child in his or her birth cohort and the income percentile rank of the parent among the parents of the same child cohort. To estimate the intergenerational mobility for each family type m we regress the income rank of the child on the rank of the parent:

$$y_{i,t} = \alpha_m + \beta_m y_{i,t-1} + \epsilon_i \tag{1}$$

where $y_{i,t}$ is the income percentile rank of the child i relative to that of other children in the same birth cohort, $y_{i,t-1}$ is the income percentile rank of the parent of child i, m denotes the family type and ϵ_i is the random error term with zero expectation. The parameters α_m and β_m denote the family-type-specific rates of absolute and relative income rank mobilities respectively. $\beta_m \in [0, 1]$ and higher value of β_m indicates lower level of intergenerational mobility.

To investigate the channel of parental influence and to control for the choices related to family, education, employment sector and residence, a model with control variables is also estimated:

$$y_{i,t} = \alpha_m + \beta_m y_{i,t-1} + c_m X_i + \epsilon_i \tag{2}$$

where β_m is the parent income rank parameter, X_i is a vector of control variables, c_m is the vector of parameters corresponding to the control variables and the rest of the notation is as defined above.

To investigate the gap in the income percentile rank between natives and second-generation immigrants, this study adopts the Oaxaca–Blinder decomposition approach (Blinder, 1973; Oaxaca, 1973). The approach enables the differential in the mean earnings rank to be decomposed into two parts: the component related to differences in the average level of characteristics (endowment effect or explained component) and the component related to differences in returns to those characteristics (coefficient effect or unexplained component).

The native-foreign differential in the mean income percentile rank can be decomposed as follows:

$$\overline{Y_N} - \overline{Y_F} = (\overline{X_N} - \overline{X_F})\widehat{\beta_N} + \overline{X_F}(\widehat{\beta_N} - \widehat{\beta_F}) \tag{3}$$

where $\overline{Y_N}$ and $\overline{Y_F}$ denote the mean income ranks of children from native and foreign families, $\overline{X_N}$ and $\overline{X_F}$ are the mean values of the explanatory variables for those two groups and $\widehat{\beta_N}$ and $\widehat{\beta_F}$ mark the estimated parameters from separate regression models for both of the family types. The first term expresses the differences in the mean income rank resulting from differences due to different endowments of observable characteristics and the second term reflects the difference in the mean outcome variable resulting from differences in the return to those characteristics.

Both terms can be further decomposed to investigate the contribution of each explanatory variable *k*:

$$(\overline{X_N} - \overline{X_F})\widehat{\beta_N} = \sum_{k=1}^{K} (\overline{X_{N,k}} - \overline{X_{F,k}})\widehat{\beta_{N,k}} \tag{4}$$

$$\overline{X_F}(\widehat{\beta_N} - \widehat{\beta_F}) = \sum_{k=1}^{K} \overline{X_{F,k}}(\widehat{\beta_{N,k}} - \widehat{\beta_{F,k}}) \tag{5}$$

For categorical regressors, the results of the detailed decomposition of the coefficient effect have been found to depend on the choice of the reference category (Oaxaca & Ransom, 1999). We opt for the solution of the identification problem by Yun (2005) and compute the decomposition based on the effects that are expressed as deviation contrasts from the grand mean, the so-called 'normalised' effects.

4. Results

4.1. Descriptive evidence

We measure the level at which the income positions are passed on to the children by using the rank-rank specification. We first focus on the individuals, whose both parents are born in Estonia (*natives*) and those, whose both parents are born abroad (*children from foreign households*), discussing the results for children with one native-born and one foreign-born parent (*mixed families*) later. Figure 1 presents the relationship between the mean child income rank versus the income percentile rank of their parents by the two groups. There is a clear linear relationship between the income rank of children and their parents – children from higher income families tend to have higher income themselves. We can also observe that for the same level of parental

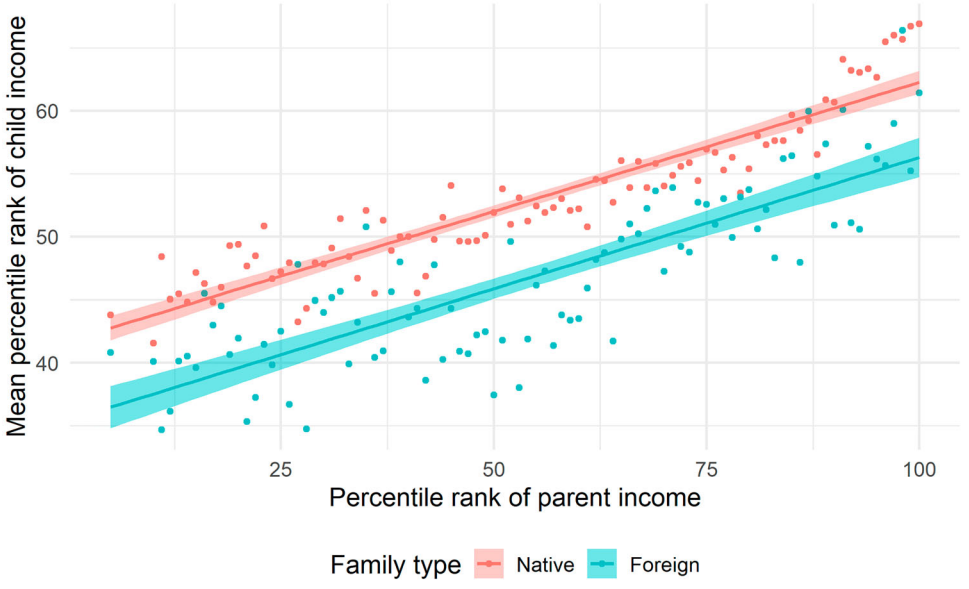

Figure 1. Mean child income rank versus parent income rank by family type. Note: The figure displays mean percentile income rank of the children versus the percentile income rank of their parents for different family types. As 9% of the parents in the sample have a summed income of zero, the percentiles 0–9 are gathered and displayed as one point per group, set at the 5th percentile. The results are robust to alternatives of setting the attributed value to 1st and 9th percentile.

income the income rank of children from foreign households tends to be on average lower than the income rank of children from native households. Lastly, the figure indicates that the rise in parental income is associated with a rise of similar magnitude in the income of children for native and foreign households, i.e. the slopes of the linear regression are similar for natives and immigrants.

Perhaps a more intuitive alternative to rank–rank plot is to measure the upward mobility by plotting the probabilities of reaching top cohort income quintile. Figure 2 displays the probability of children from each family quintile to reach the fifth income quintile of their peers by family type (see also Table A3).

As expected, there is a positive correlation between the parent income quintile and the probability of reaching the fifth quintile of the cohort income distribution. For example, persons who were, based on their parents' income, in the fifth quintile of income distribution in 2007 and whose both parents were born in Estonia, had 2.7 times higher probability of reaching the fifth quintile of the cohort income distribution in 2017 than their peers from the first quintile of the parent income distribution. For families where both parents were born abroad the children from fifth parent income quintile were around 2.8 times more likely to reach the top cohort quintile than those coming from the first quintile of the parent income distribution. This is roughly the same as for families where both parents were born in Estonia. However, there are significant differences between family types in probabilities of reaching the top cohort income quintile and these hold across all parent income quintiles.

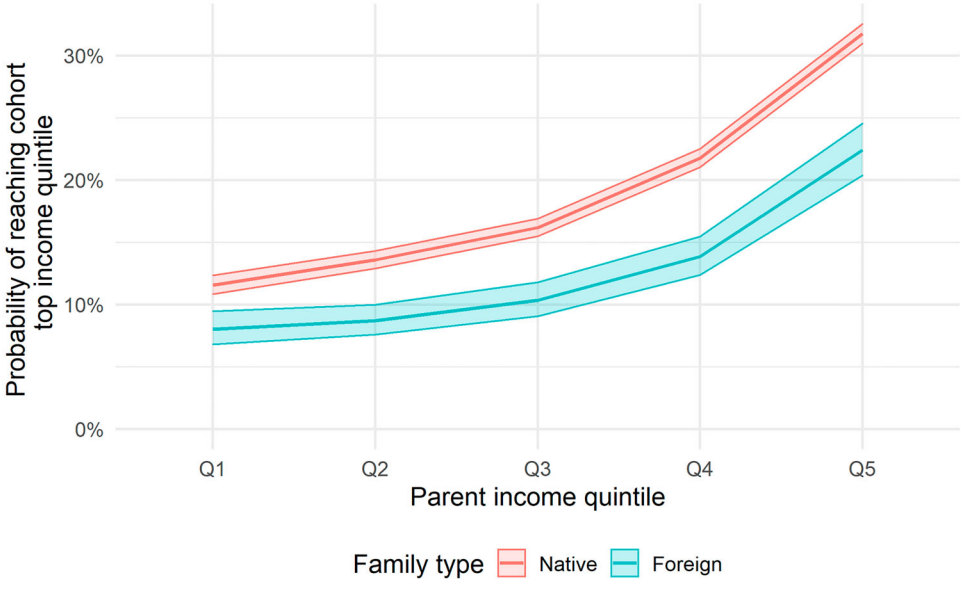

Figure 2. Probability of reaching cohort top income quintile by family type and parent income quintile.

Overall, the evidence so far indicates, that the disadvantage of having parents at the lower end of the income distribution compared to being a child of parents with a higher income is similar for natives and children from foreign households.

It can be noted though, that probability of (reaching) a high-income position is higher for natives than second-generation immigrants over the whole income distribution of parents. Thus, the difference in average income between second-generation immigrants and natives does not only result from second-generation immigrants coming from families with on average lower parental income (this would be the case, if the two curves would coincide). Rather, besides parental background other factors also play a role in creating the income differences at the level of second generation. As mentioned above these factors could include differences in cognitive skills, use of skills at work or lower returns to education.

One heavily discussed matter is the role of language skills. We try to test for the role of official language proficiency by reporting the results for mixed families. The assumption is that children with at least one native-born parent would be fluent in Estonian. Figures A1 and A2 in Appendix report the results for mixed families. Children from mixed families have a slightly steeper slope of the rank-rank curve, therefore the relationship between parent and child income seems to be slightly stronger for mixed families than for two other family types. At the lower levels of parental income, the children from mixed families perform similarly to children from foreign families, while at the top of the parental income distribution children with one native-born and one foreign-born parent are closer to the children of natives. These results indicate that part of the difference between family types could result from differences in language skills, although we cannot rule out other explanations,

such as children from mixed families having better social networks or attending better quality schools.

4.2. Regression and decomposition results

In the previous subsection, we examined the relationship between the income position of the child and the income position of the parents. In the next section, we present the results of regression and decomposition analyses to uncover the role of parental background in the economic success of the child and examine to what extent differences in parental background explain the gap between children from foreign and native households.

4.2.1. How much does parental income matter in the labour market success of the child?

The descriptive evidence above indicates that some proportion of the parental income position is carried on to the children. We next study it more formally by estimating the relative mobility parameter β_m. First row of Table 2 presents the estimated relative mobility parameter $\widehat{\beta_m}$ from equation (1). The rate of relative mobility indicates that for around 1 percentile higher income rank of the parents, children of natives have on average around 0.2 percentile higher income rank. In other words, around a fifth of the income (dis)advantage is carried on to the next generation. The rate of relative mobility is similar for children with both foreign-born parents. Children from mixed families have a slightly higher point estimate for the rate of relative mobility, however this difference is not statistically significant.

To check for the robustness of the results, relative mobility parameter is estimated using the income rank of the father and income rank of the mother and reported in the 2nd and 3rd row of Table 2. Relationship between mother income rank and child income rank is slightly stronger than the relationship between father income rank and child income rank for native and mixed families. In both cases, the estimates are lower than in the case of the combined parent income rank. This is to be expected, while studying mother and father income separately does not give advantage to the three studied groups for whom the information on both parents is available over the families for whom information on one parent is missing. Overall, the main conclusions remain the same, as the rate of relative mobility is similar for native, foreign and mixed families.

The estimates from Table 2 could be seen as the maximum estimates of parental influence on the labour market outcomes of the child. As explained above, one of the main channels of parental influence on the child's economic success is parental

Table 2. Estimated rate of relative mobility $\widehat{\beta_m}$.

Model	Native	Foreign	Mixed
Parent income rank + constant	0.211***	0.19***	0.226***
	(0.202–0.221)	(0.167–0.214)	(0.207–0.246)
Father income rank + constant	0.176***	0.166***	0.164***
	(0.163–0.188)	(0.136–0.196)	(0.139–0.19)
Mother income rank + constant	0.182***	0.166***	0.196***
	(0.169–0.195)	(0.134–0.198)	(0.171–0.222)

Note: All coefficients are significant at $p < 0.001$ level. The table presents the estimated relative mobility parameter $\widehat{\beta_m}$ from equation (1). $N_{NAT} = 26{,}224$, $N_{FOR} = 5213$ and $N_{MIX} = 7164$.

investment in the child's human capital. Thus, including the educational attainment of the child would be expected to decrease the estimated parental income rank coefficient $\widehat{\beta_m}$. Parental investment in some specific skills of the child could also impact the child's employment sector. In addition, we could assume that parental background would be, to some extent, associated with the child's residence region and family-related choices.

In order to study the channels of parental influence, models controlling for family, residential, educational and occupational covariates are estimated by equation (2) and reported in the 2nd to 6th row of Table 3. The relative mobility parameter from equation (1) is reported in the 1st row for reference. Adding the gender and the number of children only modestly reduces the relationship between the earnings of two generations. Adding the region of residence lowers the parent income rank parameter further and the most significant drop can be seen once the education is added in. Lastly, including the employment sector also has a slight effect on the parent income rank parameter.

Once the educational, occupational and residential choices are accounted for, the relationship between child and parent income rank is around 40%, 60% and 50% of the initially estimated intergenerational mobility for native, foreign and mixed families, respectively. These results indicate that although part of parental influence is carried on through the impact of parental background on the child's education and choice of residential region, around half of the relationship between the earnings of two generations still remains significant after controlling for these factors.

Note that once we control for different background characteristics, $\widehat{\beta_m}$ does not reflect the pure relative intergenerational mobility anymore. While different channels (e.g. human capital transmissions) are now controlled for, the parameter of parent income rank reflects only part of the relationship between parents and children. Thus, although statistically significant (small in magnitude) differences in the estimates of the parent income rank parameter can be detected between the native, foreign and mixed families in case of a model with all the covariates, they should not be interpreted as differences in the rate of relative mobility between different family types.

4.2.2. How much of the immigrant-native income rank gap does parental background explain?

So far, we have shown, that the parental income rank impacts the income position of the child. The relationship between parental and child income positions is of the same magnitude for children from native households and those from foreign households.

These results indicate that if the parents of second-generation immigrants are worse off than comparable natives, then a proportion of their disadvantage will persist into the next generation. Figure 3 shows the income rank distribution of the second generation and their parents by family type.[9] The children of foreign-born are less represented in the higher percentiles of the income distribution and more represented in the lower income ranks compared to the natives. The same holds for their parents in comparison with native parents. Comparing the mean income ranks of children and parents by family type, it is found that foreign parents have 7.6 points lower mean income rank than native parents, while children from foreign households have 7.7 points lower income rank than children from native households (Table 4). Overall, these results confirm that the parents of second-generation immigrants are indeed economically

Table 3. Estimated parent income rank parameter $\widehat{\beta_m}$.

Model	Native	Foreign	Mixed
Parent income rank + constant	0.211***	0.19***	0.226***
	(0.202–0.221)	(0.167–0.214)	(0.207–0.246)
+Gender	0.207***	0.188***	0.222***
	(0.198–0.216)	(0.165–0.212)	(0.203–0.242)
+Gender*no. of children	0.202***	0.186***	0.214***
	(0.193–0.212)	(0.164–0.209)	(0.195–0.233)
+Region	0.163***	0.17***	0.19***
	(0.154–0.172)	(0.147–0.193)	(0.171–0.209)
+Education	0.095***	0.119***	0.125***
	(0.086–0.104)	(0.097–0.141)	(0.107–0.144)
+Industry	0.079***	0.113***	0.111***
	(0.071–0.087)	(0.092–0.134)	(0.094–0.128)

Note: All coefficients are significant at $p < 0.001$ level. The table presents the estimated parent income rank parameter $\widehat{\beta_m}$ from equation (2). Each model includes all the variables stated above plus the variable mentioned. $N_{NAT} = 26{,}224$, $N_{FOR} = 5213$ and $N_{MIX} = 7164$ for baseline model; $N_{NAT} = 24{,}769$, $N_{FOR} = 5046$ and $N_{MIX} = 6841$ for models with control variables. Note that the composition of individuals in terms of background characteristics remains similar across the samples.

less successful than the parents of native households. Their children also lag behind native children with an income rank gap very similar to that of their parents' generation.

We next examine how much of the native-immigrant income rank gap could be explained by the differences in the average characteristics of parental background, the differences in the magnitude of influence of that background and how much is explained by other factors.

To investigate the characteristics that could explain the gap, the Blinder–Oaxaca decomposition is applied as outlined in equation (3). Table 5 shows the results for the native-foreign gap decomposition. We report the results for two different model

Figure 3. Income rank distribution of the second generation and their parents by family type.

Table 4. Income statistics for the second generation and their parents.

	Native	Foreign	Difference	*p*-value
Children				
Mean income rank	54.0	46.3	7.7	0.000
Median income rank	56	44	12	
Parents				
Mean income rank	59.2	51.6	7.6	0.000
Median income rank	63	53	10	
N	26,224	5213		

Note: *p*-value displays the estimated *p*-value from the two-sample *t*-test for equal means.

specifications. In the baseline model, we only include parent income rank and exogenous variables that cannot be influenced by parental background. In the full model, we include variables related to family, education, residential region and employment, which are likely to be influenced by parents to some extent.

According to the baseline model, the mean income rank of children from native households is estimated to be on average 7.7 percentile points higher than the mean income rank of children from foreign households. This is identical to the raw difference in rank reported in Table 4. 1.7 points (22%) of the gap is explained by the differences in endowments (characteristics), while 6.0 points (78%) can be assigned to the differences in coefficients (returns to characteristics).

The full model reports similar estimates, finding the gap of 7.8 points, where 21% (1.65/7.84) is explained by the differences in the average characteristics of the two groups and 79% (6.18/7.84) by the differences in the returns to those characteristics.

In the baseline model, the differences in the parent income rank account for ca 1.6 points of the gap and for most of the endowment effect (Table 6). Thus, when assuming that the child's choices in education, family planning, region of residence and the employment sector are fully influenced by their parents, the differences in parental background explain around 95% (1.61/1.70) of the endowment effect or 21% of the gap.

Once controlling for educational, residential, occupational and family choices, differences in the parent income rank account for ca 37% (0.61/1.65) of the endowment effect or 8% of the overall gap. The estimates of parent income rank from baseline and full model can be seen as minimum and maximum estimates of the explanatory power of parental background.

Based on earlier evidence we can assume that a large proportion of parental influence is mechanized through the impact parents have on their children's education. In addition,

Table 5. Overall decomposition results.

	Baseline		Full	
	Coef.	SE	Coef.	SE
Overall				
Native	54.014***	(0.136)	54.549***	(0.136)
Foreign	46.294***	(0.320)	46.708***	(0.322)
Difference	7.720***	(0.347)	7.841***	(0.350)
Endowment effect	1.696***	(0.092)	1.653***	(0.255)
Coefficient effect	6.025***	(0.340)	6.188***	(0.339)

Note: *$p < 0.05$, **$p < 0.01$ and ***$p < 0.001$. Table shows decomposition results for the difference in income rank for children from different family types. $N_{NAT} = 26{,}224$ and $N_{FOR} = 5213$ for baseline model; $N_{NAT} = 24{,}769$ and $N_{FOR} = 5046$ for full model.

Table 6. Endowment detailed decomposition results.

	Baseline		Full	
	Coef.	SE	Coef.	SE
Endowment effect				
Parent income rank	1.611***	(0.078)	0.611***	(0.042)
Gender	0.085	(0.048)	0.067	(0.036)
Male	0.042	(0.024)	0.033	(0.018)
Female	0.042	(0.024)	0.033	(0.018)
No. of children			−0.106***	(0.019)
*Gender*no. of children*			0.206***	(0.062)
Male*no. of children			0.323***	(0.035)
Female*no. of children			−0.118**	(0.040)
Education			1.321***	(0.100)
Lower secondary			0.259***	(0.023)
Upper secondary			0.010	(0.039)
Tertiary			1.052***	(0.070)
Region			−0.719***	(0.160)
Harjumaa			−1.059***	(0.059)
Ida-Virumaa			0.874***	(0.094)
Other			−0.534***	(0.098)
Industry			0.274*	(0.133)
Unemployed, inactive			0.364***	(0.109)
Primary			0.058***	(0.011)
Construction			−0.022**	(0.008)
LTM			−0.327***	(0.049)
HTM			−0.203***	(0.039)
LKIS			−0.192***	(0.027)
KIS			0.594***	(0.044)

Note: *$p < 0.05$, **$p < 0.01$ and ***$p < 0.001$. Table shows detailed decomposition results for the difference in income rank for children from foreign and native families. LTM – low-technology manufacturing, HTM – high-technology manufacturing, LKIS – less knowledge-intensive services, KIS – knowledge-intensive services. $N_{NAT} = 26{,}224$ and $N_{FOR} = 5213$ for baseline model; $N_{NAT} = 24{,}769$ and $N_{FOR} = 5046$ for full model.

it is probable that parents influence occupational and, to a smaller extent, residential and family-related choices of their children. We will next comment briefly on those aspects.

Educational attainment is the biggest part of the endowment effect, as differences in education levels explain 80% of the endowment effect and 17% of the overall gap. Children from foreign families tend to have on average lower education levels than natives, which seems to hinder their success in the labour market (see also Table A2).

The region of residence tends to contribute to the gap negatively as children from foreign households are overrepresented in the capital region of Harjumaa, where labour market conditions are more favourable, and underrepresented in other regions. At the same time, there is an overrepresentation of second-generation immigrants in the mainly minority populated region of Ida-Virumaa, which has a positive effect on the gap. However, the summed effect of regional location is still negative.

Differences in the employment sector do not have a substantial role in explaining the gap as a summed effect. However, contributions of some specific sectors account for larger proportion of the gap. Namely, the underrepresentation in the knowledge-intensive services sector contributes to the gap positively, while the overrepresentation in low-technology manufacturing contributes to the gap negatively.

The difference in the number of children seems to contribute to the gap around 2% negatively for females (−0.12/7.84) and 4% positively for males (0.32/7.84).

The female-male proportion does not differ considerably by different family types, consequently, it does not have a significant role in explaining the gap.

The differences described so far result from differences in the average characteristics of second-generation immigrants and natives. However, as shown above, ca 79% of the gap in the mean income rank is due to differences in coefficients, i.e. differences in the returns to characteristics included in the model and due to differences in unobserved characteristics (represented by differences in the constant variable).

The returns to parental income ranks are not statistically significantly different in the baseline model (see Table 7). Thus, in the baseline model, most of the coefficient effect is left unexplained.

Full model specification shows that differences in the return to parental income rank contribute negatively to the gap, accounting for ca 22% of the gap. Thus, we can assume that for otherwise similar individuals second-generation immigrants benefit more from the rise in parental income than children from native households.

We again focus on the different channels of parental influence. First, we detect that education is not a significant part of the coefficient effect, i.e. children from native and foreign households do not have significantly different returns to education (see also estimated coefficients of the regression models for the two groups in Table A4).

Differences in the returns to industry, however, contribute to the gap significantly. The return to employment in specific sectors accounts for 3.5 percentiles or 44% of the overall gap. Overall, natives tend to earn more on average in most sectors. This difference is most evident in the sectors of low knowledge-intensive and knowledge-intensive services,

Table 7. Coefficient detailed decomposition results.

	Baseline		Full	
	Coef.	SE	Coef.	SE
Coefficient effect				
Parent income rank	0.969	(0.656)	−1.747**	(0.592)
Gender	0.000	(0.012)	−0.074*	(0.030)
Male	−0.001	(0.163)	0.926***	(0.245)
Female	0.001	(0.175)	−1.000***	(0.265)
No. of children			−0.239	(0.396)
*Gender*no. of children*			0.166	(0.085)
Male*no. of children			−0.301*	(0.153)
Female*no. of children			0.467*	(0.237)
Education			−0.021	(0.140)
Lower secondary			−0.160	(0.195)
Upper secondary			−0.008	(0.096)
Tertiary			0.148	(0.174)
Region			1.795***	(0.226)
Harjumaa			2.202***	(0.310)
Ida-Virumaa			0.103	(0.150)
Other			−0.509***	(0.082)
Industry			3.457***	(0.430)
Unemployed, inactive			−0.118*	(0.060)
Primary			−0.132***	(0.031)
Construction			0.096	(0.106)
LTM			0.159	(0.123)
HTM			0.047	(0.060)
LKIS			1.365***	(0.204)
KIS			2.040***	(0.254)
Constant	5.056***	(0.751)	2.850**	(0.915)

Note: *$p < 0.05$, **$p < 0.01$ and ***$p < 0.001$. Table shows detailed decomposition results for the difference in income rank for children from foreign and native families. LTM – low-technology manufacturing, HTM – high-technology manufacturing, LKIS – less knowledge-intensive services, KIS – knowledge-intensive services. $N_{NAT} = 26{,}224$ and $N_{FOR} = 5213$ for baseline model; $N_{NAT} = 24{,}769$ and $N_{FOR} = 5046$ for full model.

while it is marginal in the high-technology manufacturing sector. At the same time, employment in the primary sector seems to be more beneficial for second-generation immigrants than for natives.

The difference in the returns to region of residence accounts for around 29% of the gap explained by coefficients (23% of the overall gap). Natives tend to benefit more from living in the capital region, while second-generation immigrants have higher returns to living in other regions of Estonia than natives. There seems to be no significant difference in returns to living in Ida-Virumaa, which might be explained by the small share of native population in the region and the relative unimportance of official language skills in determining labour market success in this region.

Other factors included in the models account for only a small proportion of the gap. 46% of the gap in the coefficients (or 36% of the overall gap) seems to stem from the differences in the returns to characteristics not included in our model (represented by the differences in the constant variable).

4.2.3. Discussion of results

Our estimates of relative intergenerational mobility are in the range similar to earlier findings for the Nordics. In the case of Estonia, about 20% of any economic advantage or disadvantage is passed on from parent to a child. Corak (2016) reports roughly the same level of mobility for Finland and Norway, while Italy, UK and the US have a much higher estimate of intergenerational earnings elasticity (around 0.5). Our estimates show higher mobility for the mainly Russian-speaking immigrant population in Estonia compared to intergenerational mobility reported for Russians in Russia (Borisov and Pissarides (2020) estimate intergenerational earnings correlation of around 0.35 for Russia). Thus, although these two groups might share some similarities in how common values are transmitted from parents to children (see Borjas, 1992 for the idea of ethnic capital), the differences in the institutional background in the two countries have resulted in different mobility levels for the groups.[10] Overall, our results indicate that Estonia is a relatively mobile society. The fundamental changes in the society 30 years ago have not (yet) led to a high degree of income position inheritability.

We report second-generation immigrants to have around the same level of relative intergenerational mobility in Estonia as natives. The ability transmission channel combined with parents working on positions not matching their level of education, might in some cases lead to higher intergenerational mobility for immigrants. As expected, we do not detect this relationship for the case of second-generation immigrants in Estonia. In addition, our results indicate, that while second-generation immigrants share some of the challenges in the labour market with their parents (lower language skills, segregated contact networks), these do not lead second-generation immigrants to be any more restricted by the income levels of their parents than natives would be.

The level of mobility is relatively high both for natives and second-generation immigrants. However, comparing the earnings of natives and immigrants we find the earnings gap between natives and foreign-born to be of the same magnitude for both the first and the second generation. Thus, it appears that the same level of disadvantage between natives and immigrants has persisted into the next generation.

Our focus is on the role of differences in parental background in explaining that gap. Parental resources are shown to have a clear role in explaining the gap. After including the

educational attainment of the child, the explanatory power of parental income decreases substantially, confirming the importance of intergenerational transmissions in human capital attainment. Children from lower income families tend to have lower educational attainment, which in turn decreases the income level of the children in their adulthood.

While we do find differences in education level between natives and second-generation immigrants to explain part of the gap, contrary to earlier findings for Estonia (Toomet, 2011), we do not detect differences in the returns to education. However, we do find returns to employment in specific sectors to be higher for natives than second-generation immigrants. It is possible that formal education levels do not reflect the whole range of cognitive skills needed and used at work. Ridala and Toomet (2019) find the Russian-speaking minority in Estonia to have on average lower skills, however, inclusion of skill measures only has a moderate effect in explaining the gap. In addition, Tverdostup and Paas (2017) find that including the level of skills and the use of skills at work along demographics, occupational variables and other controls explains the immigrant-native wage gap in almost all the EU member states, whereas significant differences remain in the case of Estonia. Thus, differences in skills and returns to skills, could only explain small amount of the native-immigrants earnings gap in the case of Estonia.

Part of the relationship between the income of children and parents is mediated through the region of residence. Different returns to region account for a considerable proportion of the gap in income rank between natives and second-generation immigrants. We find that the regional returns disadvantage is especially significant in relation to living in the capital city of Tallinn, where second-generation immigrants do not manage to benefit as much from the labour market conditions as natives. These results are in line with findings of Lindemann (2014) and Leping and Toomet (2008), who also find considerable differences in returns to living in the capital region. While official language skills are less essential in the minority-populated Ida-Virumaa and the second generation that lives outside of the capital or Ida-Virumaa has generally better official language skills, we would expect language skills to be one of the reasons for regional disadvantage. However, Lindemann (2014) finds that ethnic Russians experience a disadvantage in the capital region's labour market irrespective of their language skills. The results of Toomet (2011) and Kivi et al. (2020) indicate that although official language skills are important for the lower end of the wage distribution for avoiding unemployment, they are not associated with finding better positions. Thus, differences in language skills might not be the decisive factor behind different returns to regions.

While the above-described channels of human capital and regional background are important in creating the relationship between the income of parents and children, theoretical considerations and earlier empirical evidence (see e.g. Büchner et al., 2012) lead us to assume that some proportion of parental influence could be related to parents' social capital. Indeed, we find that although including the educational attainment and sector of employment of the child reduces the estimate of parental contribution considerably, the contribution of parental background remains significant in explaining the gap between natives and children of foreign-born. Controlling for other factors, differences in parental income account for around 8% of the gap in income rank. While we cannot rule out other factors, that could lead to this relationship (e.g. lower official language skills, labour market discrimination or lower motivation of both generations of immigrants), it is likely that at least part of this gap is related to poorer quality of social networks of the

foreign-born parents that would leave both themselves and their children at a disadvantage in the host country's labour market.[11]

5. Conclusions

The aim of this study is to investigate the role of intergenerational mobility in explaining the labour market success of second-generation immigrants in Estonia and the income gap between children from native and immigrant households.

We show that although first-generation immigrants were positively selected at their arrival in Estonia, changes in the society have led them to fare worse in the labour market than natives. We also find that their children, i.e. second-generation immigrants, are at lower income positions than their native counterparts.

The level at which children in Estonia inherit their income positions from their parents appears to be similar to that of Scandinavian countries. Relative intergenerational mobility does not differ considerably for natives and immigrants.

As the income position is partly inherited from parents, it is shown that differences in parental background explain up to 21% of the gap in income rank between second-generation immigrants and natives. In the large part, parental influence operates through the effect on their child's educational attainment and choice of employment sector. We find that while controlling for these factors the remaining parental influence accounts for around 8% of the gap.

In conclusion, although we would assume the second generation to have a higher level of country-specific human capital and their assimilation into the labour market be smoother than their parents, in reality the positions of second-generation immigrants in the income hierarchy have not improved compared to their parents. Second-generation immigrants are still faring worse in the labour market than natives. As we have identified in this study, this is partly a consequence of the fact that the parental 'legacy' of second-generation immigrants is poorer than that of the locals and it is passed on to the children of foreign-born with similar intensity than to the locals.

Notes

1. For the children, these challenges are likely to arise from the separation of the Estonian school system to Estonian- and Russian-language track.
2. The construction of the dataset was a part of the project 'Migration dependency and integration challenges for Estonia, employers, communities and educational system' that was approved by the Estonian Research Council and funded from the RITA programme that was supported by the European Regional Development Fund [project number RITA1/01-03-11].
3. Our focus is on analysing if children from foreign-born families have equal opportunities in the labour market. Thus, we exclude social welfare transfers to have a clear signal of the labour market success of the child.
4. The results are robust to alternatives of defining the unemployed and inactive parents as having the lowest income percentile rank of the interval (rank is defined as 1) or the highest income percentile rank of the interval (rank is defined as 9).
5. Note that capital income is earned only by 5% of children from native families, 2% of children from foreign families and 3% of children from mixed families, thus the results are expected to be robust to exclusion of the capital income.

6. The observations that were not included in the dataset in 2017 have on average lower parental income rank by around 5 percentiles. The average education level at the age of 24–26 (in year 2007) of this group is also lower than the average education level of those who remain in the dataset in 2017. Thus, it is possible that this group represents emigration of low-skilled workers. While exclusion of these observations can somewhat downward bias the estimates of intergenerational income persistence, the comparison of the mobility estimates between different family types (those with native and with foreign-born parents) is likely to be less affected by this exclusion, as differences of similar magnitude in parental income rank and child education (leavers being negatively selected in terms of these variables) can be noted within each of the studied family type.
7. The excluded observations where one parent is born in Estonia and the birth country of other is unknown are very similar in their characteristics to the children from mixed families in our sample. The children from two other groups with missing parental information have on average lower incomes than the observations included in the final sample. While the latter two family types form are relatively small group (2% of all the children who were in the dataset in 2017 in case information on both parents is missing and 5% in case one parent is foreign-born and information on the other is missing), excluding them should not lead to a significant bias in our estimates.
8. We find that once we control for parental income the differences in parental education or differences in return to parental education do not have a significant role in explaining the difference in income rank gaps between natives and children of foreign-born. Thus, the results reported in this study focus on income rank of the parents and do not include parental education.
9. Note that we exclude mixed families from the following analysis. The difference in mean income ranks is smaller between children from mixed families and natives compared to native-foreign income rank gap (5.5 percentile points compared to 7.7 percentile points). However, the role of parental income rank in explaining the native-mixed income rank gap is of the same magnitude than for the native-foreign income rank gap (differences in parental income rank explain 8%–21% of the gap in both cases). The results for mixed families are available from the authors on request.
10. We thank anonymous reviewer for suggesting this comparison.
11. We have no direct way to test how much of the social capital is carried on from parents to children, however we know that about 14% of the children from native and foreign households in our dataset work in the same sector (measured at NACE Rev. 2 level 1) as their parents.

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Appendix

Table A1. Variable description.

Variable	Description	Data source
Child income rank	Income is defined as pre-tax annual wages, income from self-employment and capital income. Social welfare transfers are not included.	Estonian Tax and Customs Board
Parent income rank	Parent income is defined as the sum of pre-tax annual wages, income from self-employment and capital income of mother and father.	Estonian Tax and Customs Board
Gender	Coded as 'male' and 'female'.	Estonian Population Registry
Education	Highest attained level of education. Coded as 'lower secondary', 'upper secondary' and 'tertiary'.	Estonian Population Registry, Estonian Education Information System, Estonian Police and Border Guard Board
No. of children	Number of children.	Estonian Population Registry
Region	Region of residence. Coded as capital region 'Harjumaa', minority-populated region 'Ida-Virumaa' and 'other'.	Estonian Population Registry
Employment sector	Sector from which highest income was gained during the observation year. Sectors are coded based on Eurostat high-tech aggregation by NACE Rev.2.	Estonian Tax and Customs Board

Note: In addition to the data sources listed in the table, the registries of the Unemployment Insurance Fund, the Health Insurance Fund and the Social Insurance Board are used to determine, based on the services used or benefits received, whether a person is residing in Estonia in 2017.

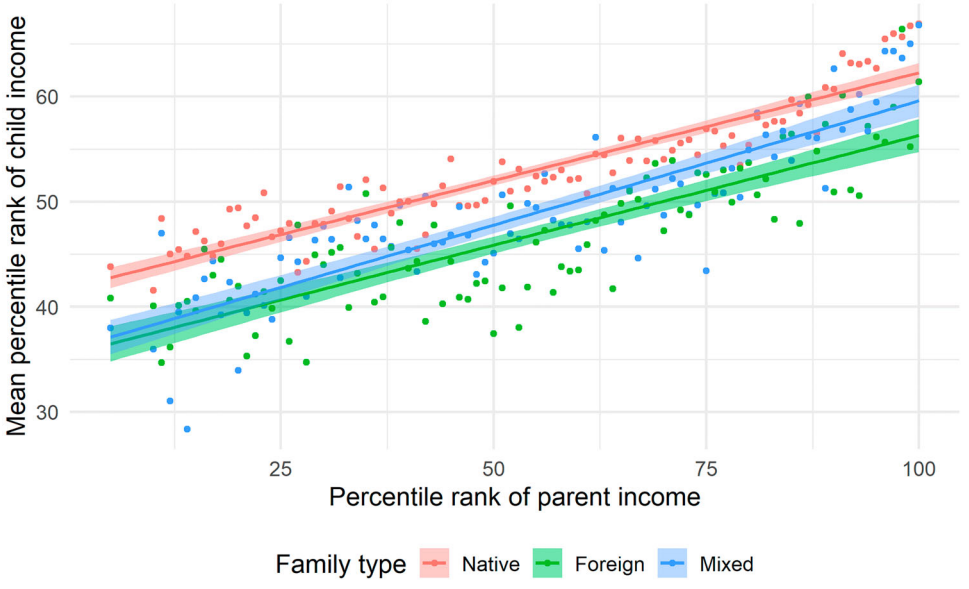

Figure A1. Mean child income rank versus parent income rank by family type (mixed families included). Note: The figure displays mean percentile income rank of the children versus the percentile income rank of their parents for different family types. As 9% of the parents in the sample have a summed income of zero, the percentiles 0–9 are gathered and displayed as one point per group, set at the 5th percentile. The results are robust to alternatives of setting the attributed value to 1st and 9th percentile (see also explanations on p. 7).

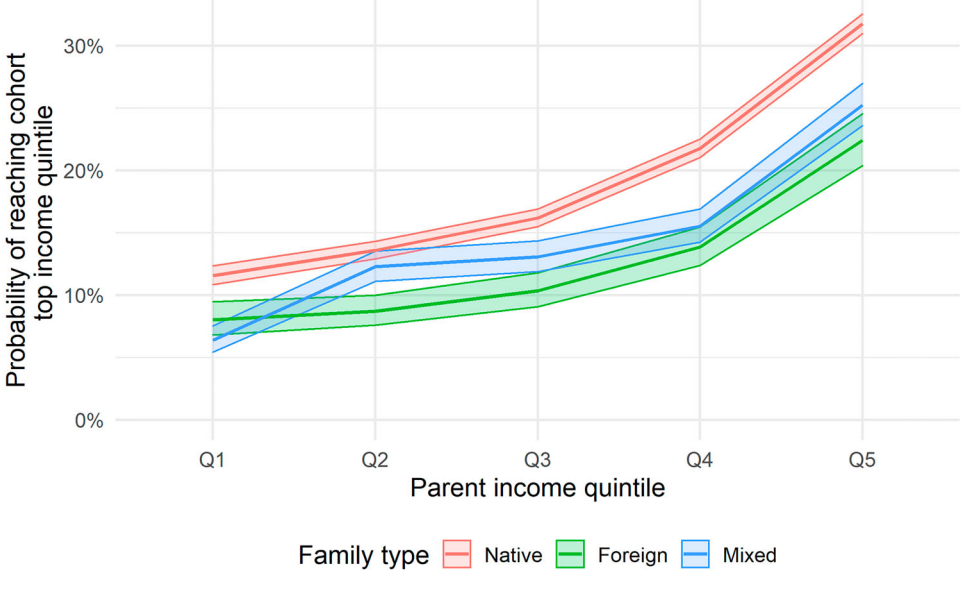

Figure A2. Probability of reaching cohort top income quintile by family type and parent income quintile (mixed families included).

Table A2. Descriptive statistics.

Characteristic	Native, $N = 26{,}224$	Foreign, $N = 5213$	Mixed, $N = 7164$
Child income rank	54.0 (28.9)	46.3 (28.0)	48.5 (28.6)
Parent income rank	59.2 (27.9)	51.6 (26.5)	53.1 (26.9)
Gender			
Female	13,090 (50%)	2668 (51%)	3554 (50%)
Male	13,134 (50%)	2545 (49%)	3610 (50%)
No. of children	1.5 (1.1)	1.3 (1.0)	1.4 (1.1)
Education			
Lower secondary or lower	4241 (17%)	858 (17%)	1339 (19%)
Upper secondary	9227 (36%)	2310 (45%)	2904 (41%)
Tertiary	12,012 (47%)	2007 (39%)	2789 (40%)
Unknown	744	38	132
Region			
Harjumaa	12,303 (48%)	3344 (65%)	4013 (57%)
Ida-Virumaa	800 (3%)	1166 (23%)	1156 (16%)
Other	12,562 (49%)	608 (12%)	1855 (26%)
Unknown	559	95	140
Industry			
Unemployed, inactive	1203 (5%)	260 (5%)	364 (5%)
Primary	606 (2%)	55 (1%)	128 (2%)
Construction	2595 (10%)	570 (11%)	719 (10%)
LTM	2908 (11%)	733 (14%)	910 (13%)
HTM	802 (3%)	228 (4%)	284 (4%)
LKIS	6224 (24%)	1471 (28%)	1976 (28%)
KIS	11,707 (45%)	1860 (36%)	2725 (38%)
Unknown	179	36	58
Father's education			
Lower secondary or lower	3346 (17%)	293 (6%)	658 (11%)
Upper secondary	8786 (44%)	2227 (49%)	2941 (50%)
Tertiary	7978 (40%)	2023 (45%)	2263 (39%)
Unknown	6114	670	1302
Mother's education			
Lower secondary or lower	1793 (9%)	145 (3%)	420 (7%)
Upper secondary	8888 (45%)	2301 (49%)	2701 (45%)
Tertiary	9211 (46%)	2279 (48%)	2847 (48%)
Unknown	6332	488	1196

Note: Statistics presented: mean (SD); *n* (%).

Table A3. Probability of reaching cohort top income quintile, by family type and parent income quintile.

Family type	Q1	Q2	Q3	Q4	Q5
Native	11.6% (10.8%–12.3%)	13.6% (12.9%–14.3%)	16.2% (15.5%–16.9%)	21.8% (21%–22.5%)	31.7% (31%–32.5%)
Foreign	8% (6.8%–9.5%)	8.7% (7.6%–10%)	10.4% (9.1%–11.8%)	13.9% (12.4%–15.5%)	22.4% (20.4%–24.6%)
Mixed	6.4% (5.4%–7.5%)	12.3% (11.1%–13.5%)	13.1% (11.9%–14.3%)	15.5% (14.2%–16.9%)	25.2% (23.6%–27%)

Note: Table shows probabilities for children from different family types and quintiles (at the age of 24–26) to reach the 5th income quintile of their peers ten years later. The upper and lower values of the confidence interval at 95% confidence level are presented in the parenthesis. $N_{NAT} = 26{,}224$, $N_{FOR} = 5213$ and $N_{MIX} = 7164$.

Table A4. Linear regression results of the full model – explanatory factors on child income rank.

	Native		Foreign	
	Coef.	SE	Coef.	SE
Parent income rank	0.079***	(0.004)	0.113***	(0.011)
Female	−5.638***	(0.407)	−1.786	(0.934)
No. of children	2.110***	(0.152)	2.841***	(0.389)
Female*no. of children	−5.559***	(0.210)	−6.674***	(0.524)
Education				
Upper secondary	5.567***	(0.345)	5.869***	(0.814)
Tertiary	19.435***	(0.360)	18.989***	(0.877)
Region				
Ida-Virumaa	−10.209***	(0.703)	−7.232***	(0.687)
Other	−7.209***	(0.243)	0.102	(0.848)
Industry				
Primary	46.255***	(0.934)	54.687***	(2.824)
Construction	43.338***	(0.695)	39.933***	(1.519)
LTM	52.685***	(0.682)	49.030***	(1.466)
HTM	56.592***	(0.874)	53.003***	(1.812)
LKIS	46.110***	(0.645)	38.671***	(1.391)
KIS	47.859***	(0.635)	39.547***	(1.392)
Constant	1.232	(0.700)	−4.359**	(1.514)

Note: *$p < 0.05$, **$p < 0.01$ and ***$p < 0.001$. Table shows linear regression results on the income rank of children by different family types. LTM – low-technology manufacturing, HTM – high-technology manufacturing, LKIS – less knowledge-intensive services, KIS – knowledge-intensive services. $N_{NAT} = 24{,}769$ and $N_{FOR} = 5046$.

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Short-term inflation projections model and its assessment in Latvia

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ABSTRACT

This paper builds a short-term inflation projections (STIP) model for Latvia. The model is designed to forecast highly disaggregated consumer prices using cointegrated ARDL approach of [Pesaran, M., & Shin, Y. (1998). An Autoregressive Distributed Lag Modelling Approach to Cointegration Analysis. *Econometric Society Monographs*, 31, 371–413.]. We assess the forecast accuracy of STIP model using out-of-sample forecast exercise and show that our model outperforms both aggregated and disaggregated AR (1) benchmarks. Across inflation components, the forecast accuracy gains are 20–30% forecasting 3 months ahead and 15–55% forecasting 12 months ahead.

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1. Introduction

Price stability is the ultimate goal of monetary policy in the euro area. Monetary policy decisions are based not only on the current level of inflation but also on the projected one. Therefore, short-term inflation projection is an important input in decision-making process. In the euro area, virtually each central bank develops short-term inflation projections for the respective country, which are then aggregated to euro area inflation projections, providing inputs to the ECB's monetary policy decisions.

Against this backdrop, we build a model, which projects inflation developments over a short-term horizon (12 months) in Latvia, and call it the STIP model. It plays an important role in assessing short-term inflation projections in the context of BMPEs/NIPEs, which are procedural frameworks of the Eurosystem/ECB macroeconomic projections.[1]

The literature uses various econometric techniques to forecast inflation. Predominantly, authors exploit univariate and multivariate models, such as ARIMA (Huwiler & Kaufmann, 2013; Marcellino et al., 2006) vector autoregressions (Banbura et al., 2010; Giannone et al., 2014)) and dynamic factor models (Boivin & Ng, 2005; Stock & Watson, 1999, 2002). In this paper, we follow a growing amount of literature, which uses cointegration relationships in forecasting inflation (Antoniades et al., 2004; Aron & Muellbauer, 2012, 2013; Espasa & Albacete, 2007; Espasa et al., 2002; Senra et al., 2002; Stakenas, 2015). The literature finds out that isolating the equilibrating relationships contributes to greater

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accuracy of inflation forecasts relative to the benchmark models. The literature also traditionally uses standard cointegration tests of Engle and Granger (1987), Phillips and Ouliaris (1990) and Johansen (1995), which require variables to follow I(1) process. This necessitates to run various unit root tests, as unit roots are known to suffer some power problems. In the paper, we use a cointegrated ARDL modelling approach introduced in Pesaran and Shin (1998) and Pesaran et al. (2001). Cointegrated ARDL model is robust to the misspecification of integration orders of variables and easy to implement.

Inflation can be significantly affected by various heterogeneous shocks. One may require to disaggregate headline inflation into components in order to better capture the impact of these shocks. There is a couple of merits of disaggregated approach. First, by disaggregating headline inflation, one can better capture dynamic properties using specific information for particular component and hence obtain more accurate forecasts. Second, forecast errors of individual components may partly cancel out leading to more accurate forecast of the aggregate (Hendry & Hubrich, 2011; Hubrich, 2005). On the contrary, misspecification of the dynamics of individual components may ruin forecast accuracy of the aggregate. Similarly, forecast errors might not cancel out if unexpected shock affects several components in the same direction. In empirical studies on consumer prices, there is an evidence that the disaggregated approach proved to be more accurate than the aggregated one, e.g. Duarte and Rua (2007), Moser et al. (2007), Reijer and Vlaar (2006), Bandt et al. (2007), Aron and Muellbauer (2012), and Marcellino et al. (2003).

The degree of disaggregation is usually somewhat ad hoc in the literature. As a rule of thumb, authors single out the most heterogeneous or volatile series, which apparently are driven by specific explanatory factors. The literature usually distinguish five consumer price aggregates: unprocessed food, processed food, energy, non-energy industrial goods and services. This approach is followed by Espasa et al. (2002), Fritzer et al. (2002), Reijer and Vlaar (2006), Duarte and Rua (2007), Bermingham and D'Agostino (2014) and Alvarez and Sánchez (2017). Several papers disaggregate the consumer price index even further, e.g. Aron and Muellbauer (2012) break down headline consumer prices in 10 components, Stakenas (2015) – in 21 components, Bermingham and D'Agostino (2014) – in 32 components, Duarte and Rua (2007) – in 59 components, Huwiler and Kaufmann (2013) – in 182 components. In this paper, we do not aim at studying the optimal degree of disaggregation but suggest our own level of disaggregation into 33 components which is largely based on expert judgement and remains fixed throughout the paper.

We find that the STIP model forecasts accurately inflation and its components over 12 months ahead. We assess the model's out-of-sample forecast accuracy and find that the STIP model statistically significantly outperforms an AR(1) benchmark in real time.

The structure of the paper is as follows. Section 2 describes the data and methods. Section 3 presents estimation results. Section 4 assesses the model's out-of-sample forecast performance, while Section 5 concludes.

2. Data and methods

2.1. Data

We use 95 individual HICP indices from Eurostat and the Central Statistical Bureau of Latvia (CSB) over the period from 2005 to 2018. The individual indices are aggregated

to obtain special aggregates (like unprocessed meat or non-energy industrial goods), which we use in modelling consumer prices according to ECOICOP5 classification.

We also use various data as determinants of consumer prices. To model car fuel prices, we use crude oil prices (Bloomberg, Brent mark, daily data), refined petrol and diesel prices (Bloomberg and Reuters respectively, daily data) and retail car fuel prices before and after taxes (the weekly Oil bulletin of the European Commission), as well as the EUR–USD exchange rate obtained from the ECB (Statistical Data Warehouse).

Global food commodity prices, which mainly affect consumer prices of food products, are represented by European farm-gate prices and other producer prices of cereals, dairy and meat and are published by the DG AGRI of the EC. For global prices of sugar and coffee, we employ international commodity prices (Bloomberg). We also use Nasdaq salmon spot prices as a proxy for international fish prices.

There are several domestic variables, which we use in modelling and forecasting consumer prices (all published by CSB) – the average wage rate as a measure of domestic labour costs, the hotel occupancy rate to control for demand pressures in accommodation services and the internet usage to explain communication prices.

Ultimately, explanatory variables should be attributed the future path over the forecast horizon in order to make inflation projections. Almost all foreign variables follow the assumptions provided by the ECB during official NIPE forecast rounds, i.e. crude oil prices, global food commodity prices and the exchange rate. Whereas the projections of labour costs, salmon prices, the hotel occupancy rate and internet usage are elaborated by Latvijas Banka internally. All consumer prices (except the administered prices and energy prices) are seasonally adjusted by X-12-ARIMA with default settings.

2.2. Modelling approach

We employ the ARDL modelling approach following Pesaran and Shin (1998) and Pesaran et al. (2001) to empirically assess long-run level relationships between consumer prices and their determinants. The ARDL approach enables us to test for a level relationship irrespective whether the regressors are of the order $I(0)$ or $I(1)$.

The general representation of ARDL is as follows:

$$y_t = a_0 + a_1 t + \sum_{i=1}^{p} \psi_i y_{t-i} + \sum_{j=1}^{k} \sum_{l_j=0}^{q_j} \beta_{j,l_j} x_{j,t-l_j} + \epsilon_t \tag{1}$$

where $\epsilon_t \sim i.i.d.N(0, \sigma^2)$, a_0 is a constant, t is a trend; a_1, ψ_i, β_{j,l_j} are respectively the coefficients addressing the linear trend, lags of dependent variable y_t, and lags of independent variables $x_{j,t}$, for $j = 1, \ldots, k$; and q_j is the number of lags for the independent variable j.

Pesaran et al. (2001) show that the vector autoregression framework could be reduced to the conditional error correction (CEC) form under certain assumptions. Moreover, they show that there is a one-to-one correspondence between the CEC model and the ARDL model presented in Equation (1). Hence, the ARDL model representation could be

transformed to the following CEC form:

$$\Delta y_t = a_0 + a_1 t + b_0 y_{t-1} + \sum_{j=1}^{k} b_j x_{j,t-1} + \sum_{i=1}^{p-1} c_{0,i} \Delta y_{t-i} + \sum_{j=1}^{k} \sum_{l_j=1}^{q_j-1} c_{j,l_j} \Delta x_{j,t-l_j} + \sum_{j=1}^{k} d_j \Delta x_{j,t} + \epsilon_t \quad (2)$$

where the third and fourth terms of Equation (2), i.e. the lagged terms of dependent variable y_{t-1} and regressors $x_{j,t-1}$ represent a cointegration relationship. Pesaran et al. (2001) propose a bounds test for cointegration as a test on the significance of parameters in the cointegration relationship. In fact, the null hypothesis tests whether coefficients $b_0 = b_j = 0$, for all j, mean that there is no long-run relationship between y_t and x_t.

Alternatively, if the coefficients are not zeros, we reject the null and conclude that there is a cointegration relationship. The proposed test is a standard *F*-test, but since asymptotic distributions of this statistic are non-standard under the null, Pesaran et al. (2001) provide critical values. Pesaran et al. (2001) also distinguish five different specifications of the CEC model depending on whether the constant and trend integrate (mutually or separately) into the error correction term. In our equation specifications we additionally report whether the trend or constant is included into the cointegration relationship.

The methodology mainly requires that the order of integration of the variables is not greater than *I*(1), which is indeed true for most economic variables, and ARDL equations should not exhibit serial correlation to ensure cointegration among the variables. We test for the integration order of variables using ADF test statistics, and all of them are not greater than *I*(1), meaning that variables are first difference stationary (see Table A1). The cointegration results between consumer prices and their determinants are tested using the Pesaran–Shin–Smith bounds test and reported in Table A2. The null hypothesis of no serial correlation is tested using the Breusch–Godfrey LM test and is not rejected in all equations (see Table A3). Heteroskedasticity is tested using the Breusch–Pagan–Godfrey test. The null hypothesis is not rejected in a large number of equations, meaning that the errors are homoskedastic. But in cases where heteroskedasticity is present, we use Newey–West adjusted standard errors. Other statistics of the estimated equations are reported in Table A4.

3. Model overview

We pursue a disaggregated approach setting up the STIP model. We break down headline consumer price index into 33 components: 5 components of unprocessed food prices, 12 components of processed food prices, 5 components of energy prices, 3 components of non-energy industrial goods (NEIG) prices and 8 components of services prices (the total sum of the consumer price weights of all 33 components is equal to 100%). The reason for such a detailed disaggregation is that different driving forces affect various components of consumer prices. Even within broad price aggregates, such as food or services prices, determinants may significantly differ. For instance, some service prices may respond to energy and food price developments. Consequently, if disaggregation of services prices is not sufficient, it may fail to identify linkages to global energy and food prices and is

likely to produce biased forecasts. Second, a pass-through of costs to consumer prices differ in terms of speed and magnitude among consumption products. Hence, detailed disaggregation allows us to estimate more accurately the speed and magnitude of the pass-through to HICP components.

There is no any methodology or statistical tests which allows to determine an optimal number of components to forecast inflation. This is a pure empirical question. We do not aim at studying the optimal level of disaggregation, nonetheless we suggest our own level of disaggregation as stated before. As a rule of thumb, we single out the most heterogeneous and volatile components (e.g. travel-related components), and the components, which have sensible explanatory variables available in public domain (e.g. domestic meat prices are followed by developments in the global meat prices).

As an overview, consumer prices are affected by the four main factors in our model. Crude oil prices are the main factor directly driving consumer prices of energy and indirectly, through car fuel prices, affect consumer prices of food and some services. Global food commodity prices exert a pressure mainly on consumer prices of unprocessed and processed food, which indirectly affect also consumer prices of catering services. The impact of nominal effective exchange rate (NEER) is mainly found in consumer prices of non-energy industrial goods (NEIG). Finally, domestic labour costs -- directly and indirectly -- affect almost all components of consumer prices. All the components of consumer prices and its determinants are described in the next sections.

3.1. Unprocessed food prices

We model consumer prices of unprocessed food, disaggregating them into five components. They are mainly driven by global food commodity prices and domestic labour costs (Table 1).

Error correction seems to be particularly fast for unprocessed vegetables and unprocessed fruits, with 26–30% of the adjustment towards fundamental price level taking place within 1 month. Such a fast price adjustment might reflect the fact that the respective consumer prices are highly volatile and depend on (rapidly changing) weather conditions.

Consumer prices of several unprocessed food items are closely linked to the global food commodity prices. The long-run elasticity of unprocessed meat consumer prices to the EU producer prices of meat is about 0.5. Elasticity of unprocessed fish consumer prices to international salmon price index is of similar magnitude. We do not find any statistically significant relationship between consumer prices of unprocessed fruits and the respective DG AGRI indices, which could reflect the fact that for many fruits DG AGRI prices are missing at least for some periods of time. Thus we linked consumer prices of unprocessed fruits to the total DG AGRI food price index. Furthermore, we linked consumer prices of eggs to DG AGRI prices of cereals, since cereals are used as a feed for chickens and thus account for some part of egg production costs.

The long-run elasticity of unprocessed food consumer prices to domestic labour costs is about 0.47–0.56, except for unprocessed fish which recorded somewhat lower elasticity at 0.33. Note that unprocessed fish prices are the only unprocessed food item showing a robust association with car fuel prices.

Table 1. Modelling unprocessed food prices: error correction and long-run coefficients.

		Long-run coefficients				
	Error correction	Labour costs	Car fuel	Global food	Trend	Constant
Unprocessed meat	−0.13*** (0.02)	0.50*** (0.06)		0.53*** (DG AGRI meat) (0.11)	−0.002*** (0.00)	
Unprocessed fish	−0.12*** (0.02)	0.33*** (0.09)	0.36*** (0.11)	0.50*** (Nasdaq salmon) (0.09)		
Eggs	−0.11*** (0.02)	0.47*** (0.07)		0.23** (DG AGRI cereals) (0.10)		
Unprocessed fruits	−0.26*** (0.04)	0.56*** (0.07)		0.37*** (DG AGRI food) (0.09)	−0.002*** (0.00)	
Unprocessed vegetables	−0.30*** (0.06)	0.47*** (0.06)				1.50*** (0.41)

Notes: *, ** and *** define statistical significance level at 10%, 5% and 1% respectively. Standard errors are in parentheses. Models are estimated using monthly data from January 2005 to December 2018. All variables are seasonally adjusted and expressed in logs. The lag order is selected by minimizing the Schwarz criterion. Time dummies are included in the estimation of unprocessed meat (2008m06, 2015m06), unprocessed fish (2007m02, 2010m03, 2013m08, 2018m06, 2018m12), eggs (2012m04, 2017m11, 2017m12), unprocessed fruits (2005m07, 2009m08, 2013m09, 2018m08), unprocessed vegetables (2005m02, 2018m09).

We also identify a negative trend in consumer prices of unprocessed meat and unprocessed fruits, controlling for price determinants. This negative trend might reflect a growing competition among retailers or a greater availability of cheaper imports.

3.2. Processed food prices

We model consumer prices of processed food, disaggregating them into 12 components. The monthly speed of adjustment towards the equilibrium price level is somewhat slower than in the case of unprocessed food (often below 10%), with a notable exception of processed meat prices (18%). In all cases, however, error correction coefficients remain highly statistically significant (Table 2).

The highest long-run elasticity of consumer prices to global food commodity prices is evident for the consumer prices of dairy products (as well as oils and fats) to the EU producer prices of dairy products at about 0.6–0.7. A high elasticity might reflect the fact that dairy is the only DG AGRI index, which partly consists of processed products ready for the final consumption (such as cheese).

Elasticity of non-alcoholic beverages consumer prices to global coffee prices is 0.42. The magnitude of elasticity is plausible, considering that share of coffee in non-alcoholic beverage consumption is about 45%. In turn, consumer prices of sugar and chocolate, and other miscellaneous food react to international sugar prices with elasticity close to 0.3. Consumer prices of bread and cereals tend to react to DG AGRI cereals price index; a moderate elasticity points to the fact that the price of grain reflects a minor part of bread production costs.

Several HICP components of processed food depend on the prices of the respective unprocessed food. This link is particularly obvious for the prices of processed meat, fish and vegetables. Several prices of processed food are affected also by retail prices of car fuel (with long-run elasticity of about 0.2–0.3). Furthermore, all consumer prices of processed food directly or indirectly are affected by domestic labour costs. The magnitude of elasticities broadly reflects the share of labour costs and transportation costs in the respective industry. For instance, in the case of dairy products (as well as of sugar and

Table 2. Modelling processed food prices: error correction and long-run coefficients.

		Long-run coefficients						
	Error correction	Labour costs	Unprocessed HICP	Car fuel	Global food	NEER	Trend	Constant
Processed meat	−0.18*** (0.02)		0.85*** (meat) (0.02)			0.21*** (0.07)		0.71*** (0.07)
Processed fish	−0.07*** (0.01)	0.21*** (0.07)	0.18** (fish) (0.07)	0.20*** (0.06)				1.43*** (0.30)
Processed fruits	−0.09*** (0.02)	0.65*** (0.05)		0.31*** (0.09)				
Processed vegetables	−0.08*** (0.02)		0.81*** (vegetables) (0.08)					0.99*** (0.34)
Dairy products	−0.11*** (0.01)	0.41*** (0.03)		0.20*** (0.07)	0.57*** (dairy) (0.11)			−1.67*** (0.30)
Bread and cereals	−0.09*** (0.01)	0.74*** (0.07)			0.26*** (cereals) (0.03)		−0.002*** (0.0004)	
Oils and fats	−0.05*** (0.01)	0.45*** (0.10)			0.72*** (dairy) (0.23)			
Sugar and chocolate	−0.06*** (0.01)	0.38*** (0.05)		0.18*** (0.08)	0.27*** (sugar) (0.06)			
Other food	−0.07*** (0.01)	0.33*** (0.05)			0.31***(food) (0.06) 0.22***(sugar) (0.03)			
Non-alcoholic beverages	−0.11*** (0.01)	0.16*** (0.04)		0.27*** (0.06)	0.42*** (coffee) (0.04)			
Alcoholic beverages	−0.08*** (0.01)	0.24*** (0.05)			0.10*** (cereals) (0.04)			2.56*** (0.25)
Tobacco	−0.004*** (0.0008)	0.79*** (0.08)						

Notes: *, ** and *** define statistical significance level at 10%, 5% and 1% respectively. Standard errors are in parentheses. Models are estimated using monthly data from January 2005 to December 2018. All variables are seasonally adjusted and expressed in logs. The lag order was selected by minimizing the Schwarz criterion. Time dummies are included in the estimation of processed meat (2011m09, 2012m12), processed fish (2008m11, 2009m01, 2014m04), processed fruits (2008m03, 2014m10, 2015m03, 2015m08), processed vegetables (2011m07, 2006m07, 2009m07, 2009m08, 2010m06, 2010m07, 2013m06, 2013m08, 2015m06), dairy products (2009m01, 2009m02, 2011m01, 2007m10, 2007m11, 2014m09), bread and cereals (2006m11, 2007m11, 2010m10, 2013m05), oils and fats (2007m10, 2008m01, 2017m01, 2017m08, 2018m05, 2018m07), other food (2005m07, 2008m04, 2009m01, 2009m12, 2011m04), non-alcoholic beverages (2009m02, 2012m01, 2012m09, 2014m05, 2018m02, 2018m11), alcoholic beverages (2009m02, 2009m07, 2018m03). NEER stands for nominal effective exchange rate.

chocolate), the elasticity of consumer prices to labour costs is at least twice higher than to car fuel. On the contrary, consumer prices of non-alcoholic beverages tend to react to car fuel prices more than to domestic labour costs. We also find a positive relation between consumer prices of processed meat and the nominal effective exchange rate (NEER). It might reflect large meat imports from Poland – a country whose currency showed large exchange rate fluctuations vis-à-vis the euro during the past 15 years .[2] Moreover, controlling for respective price determinants, we add a negative trend into the respective long-run equation of bread and cereals, which apparently reflects the growing competition in the industry.[3]

3.3. Energy prices

We distinguish five components of HICP energy prices: car fuel, natural gas, heat energy, electricity and solid fuel.

Developments in consumer car fuel prices strongly reflect movements in crude oil prices in global markets. We model these relationships in the spirit of Meyler (2009) – from upstream to downstream prices – accounting for refining, distribution, retailing margins and indirect taxes. Since margins and excise tax rates differ for major car fuel types, thus diesel and petrol prices are modelled separately and then aggregated to consumer car fuel price. The equations in Table 3 depict elasticities of refined petrol and diesel prices to crude oil prices.[4] Elasticities are close to one in both cases, meaning that an oil price increase by 1 euro cent per litre translates into the price increase of refined petrol and refined diesel by about 1 euro cent. At the next stage, refined oil prices feed into retail consumer prices without taxes (both in euro per litre). Again, elasticities are close to one for retail prices of both petrol and diesel. Finally, we add excise and VAT taxes, which account for a large share in consumer car fuel prices.

There is also a strong long-term link between crude oil prices and the consumer prices of natural gas and heat energy (Table 4). In Latvia the prices of natural gas are entirely dependent on prices of crude oil, even though there is no direct link between them in a sense of production costs. Given the fact that in Latvia almost all gas supply is imported from Russia, determination of 'fair' price of natural gas is based on the principle of price of energy source. Hence the price of natural gas is naturally linked to the price of crude oil.

Table 3. Modelling car fuel prices: error correction and long-run coefficients.

		Long-run coefficients				
	Error correction	Oil (euro)	Refined prices	Labour costs	Trend	Constant
Refined petrol	−0.09***	0.95***			0.00006***	
	(0.01)	(0.04)			(0.00)	
Refined diesel	−0.06***	1.12***				
	(0.01)	(0.04)				
Retail petrol	−0.10***		0.99***	0.00006***		0.08***
	(0.02)		(0.03)	(0.00)		(0.02)
Retail diesel	−0.17***		1.04***	0.00008***		0.07***
	(0.02)		(0.02)	(0.00)		(0.01)

Notes: *, ** and *** define statistical significance level at 10%, 5% and 1% respectively. Standard errors are in parentheses. Models are estimated using weekly data from January 2005 to December 2018. All variables are expressed in euro per litre. The lag order is selected by minimizing the Schwarz criterion. Time dummies are included in the estimation of refined petrol (29/08/2005), retail petrol (05/09/2005, 12/09/2005, 02/02/2009, 02/03/2009), retail diesel (09/03/2015).

Table 4. Modelling other energy prices: error correction and long-run coefficients.

		Long-run coefficients		
	Error correction	Oil (euro)	Timber	Labour costs
Natural Gas	−0.019***	1.04***		
	(0.005)	(0.19)		
Heat Energy	−0.017***	0.79***		
	(0.004)	(0.10)		
Solid fuel	−0.07***		0.50***	0.41***
	(0.01)		(0.15)	(0.08)

Notes: *, ** and *** define statistical significance level at 10%, 5% and 1% respectively. Standard errors are in parentheses. Models are estimated using monthly data from January 2005 to December 2018. All variables are seasonally adjusted and expressed in logs. The lag order is selected by minimizing the Schwarz criterion. Time dummies are included in the estimation of natural gas (2004m12, 2005m10, 2008m10, 2009m07, 2010m07), heat energy (2007m10, 2008m02, 2008m10, 2009m05, 2010m04, 2012m01), solid fuel (2006m09, 2007m02, 2013m10, 2018m01, 2018m10).

Heat energy prices are also linked to crude oil prices. This reflects the fact that most of the heat energy in Latvia is produced using natural gas, which again ultimately links heat energy prices to crude oil prices. Consumer solid fuel prices in Latvia mainly represent the price of firewood. Thus we link solid fuel prices to Latvian timber prices and domestic labour costs.

We do not model electricity prices and there is a couple reasons. First, electricity market in Latvia was fully regulated before 2015 and it prevents us to use econometric techniques. Second, despite the fact that since 2015 electricity wholesale prices strongly correlate with the respective prices in Estonia, Lithuania and the Scandinavian countries due to the connection to the Nord Pool electricity market, retail electricity consumer prices resemble behaviour of administered prices. The majority of households have fixed-price contracts with the main electricity supplier, thereby consumer price of electricity changes infrequently. Hence, during forecast exercises we set electricity prices unchanged (flat).

3.4. Non-energy industrial goods prices

Developments in prices of individual NEIG items exhibited opposite patterns over the last 15 years. The prices of durable goods were broadly stable up to 2008 and then significantly and monotonically decreased over the last 10 years. The major share of these goods is imported, and their prices might reflect hardly measurable factors, such as global technical progress or integration of low-wage countries into global value chains. Consumer prices of semi-durable goods (mainly clothes and footwear) show considerable seasonality, but over the years the price level remained almost unchanged. In turn, consumer prices of non-durable industrial goods were steady rising over time. Such a variation in trends and volatilities of NEIG prices precludes us to model NEIG prices as a single aggregate. Instead, we divide NEIG items in three parts – (i) NEIG prices, which to a large extent are driven by domestic activity, (ii) other NEIG prices, (iii) administered prices (i.e. water supply). In order to understand which NEIG prices are driven by domestic economic activity and correlate with domestic labour costs, we regress each NEIG item on labour costs separately. Those NEIG items, which statistically significantly correlate with labour costs, we aggregate them and classify as non-energy industrial goods with domestic value added.[5] The rest of NEIG prices are aggregated and classified as 'other goods' (Table A5). The former is modelled using ARDL, but the latter follows AR model with

Table 5. Modelling NEIG prices: error correction and long-run coefficients.

		Long-run coefficients		
	Error correction	Labour costs	NEER	Trend
NEIG with domestic value added	−0.11*** (0.01)	0.30*** (0.02)	0.26* (0.14)	−0.001*** (0.00)

Notes: *, ** and *** define statistical significance level at 10%, 5% and 1% respectively. Standard errors are in parentheses. Models are estimated using monthly data from January 2005 to December 2018. All variables are seasonally adjusted and expressed in logs. The NEER is defined as an increase means depreciation. The lag order is selected by minimizing the Schwarz criterion. Time dummies are included in the estimation of NEIG (2009m01, 2010m12, 2011m08, 2013m04).

optimal number of lags. Water supply is administered price and changes infrequently. Therefore we do not model it and during forecast exercises we set price of water supply unchanged (flat).

NEIG with domestic value added account for more than a half in consumer spending on non-energy industrial goods. Its long-run elasticity to domestic labour costs is about 0.30 (Table 5). As some of these goods are imported, we find a positive correlation of consumer prices with the NEER. We also include a negative trend in equation for NEIG with domestic value added, which are likely to reflect the increasing competition or greater availability of cheap imports.[6]

3.5. Services prices

Services prices, akin to NEIG, also reflect many various behaviour patterns and trends. Therefore, we divide all services prices in eight components: prices of catering, communication, accommodation, air transport, package holidays, education, administered prices and other market services prices (hereinafter, labour-intensive services prices).

Labour-intensive services are the largest group of services (see Table A6; more than 40% of consumer spending on services), which shares a common price dynamics and exhibits a very high long-run price elasticity to labour costs (0.77; Table 6). Likewise, a high elasticity to labour costs is also observed in catering services.

Accommodation prices are affected not only by labour costs but also by interaction of demand and supply, reflected by the hotel room occupancy rate. In turn, package holiday prices are affected both by labour costs and prices of air transport, since package holidays are defined as holidays whose costs of travel and accommodation are bundled and sold in one transaction. We link the prices of communication services to labour costs and internet usage, while consumer prices of air transport to the costs of fuel. Administered services prices ultimately represent labour costs. Education services in Latvia are mostly publicly financed and price changes occur infrequently and largely in conjunction with a start of academic year. This regularity precludes to use econometric techniques. We single out education services prices out of services prices and set them flat during forecast exercises.

4. Forecast evaluation

This section takes a formal forecast evaluation exercise. We assess forecast accuracy in terms of RMSFEs and compare the results of STIP model with a benchmark AR(1) model.

Table 6. Modelling services prices: error correction and long-run coefficients.

		Long-run coefficients				
	Error correction	Labour costs	HICP item	Other variables	Trend	Constant
Labour-intensive services	−0.14*** (0.02)	0.77*** (0.03)			−0.001*** (0.00)	
Catering	−0.11*** (0.02)	0.75*** (0.05)	0.12** (food) (0.05)		−0.001*** (0.00)	
Administered Services	−0.05*** (0.005)	0.99*** (0.22)			−0.002*** (0.001)	
Communication	−0.02*** (0.003)	0.89*** (0.31)		−0.96*** (internet usage; %) (0.33)		2.80** (1.41)
Accommodation	−0.28*** (0.04)	0.10** (0.05)		0.38*** (hotel occupancy; %) (0.04)	−0.002*** (0.00)	
Air transport	−0.06*** (0.01)		0.76*** (fuel) (0.25)		−0.005*** (0.00)	
Package holidays	−0.19*** (0.04)	0.50*** (0.07)	0.32** (air transport) (0.13)		−0.001** (0.00)	

Notes: *, ** and *** define statistical significance level at 10%, 5% and 1% respectively. Standard errors are in parentheses. Models are estimated using monthly data from January 2005 to December 2018. All variables are seasonally adjusted and expressed in logs. The lag order is selected by minimizing the Schwarz criterion. HICP for food means HICP for food prices, excluding alcohol and tobacco. Time dummies are included in the estimation of labour-intensive services (2007m05, 2008m02, 2009m01, 2009m09, 2014m01, 2016m07, 2018m01), catering (2005m09, 2009m01, 2009m09, 2013m01, 2013m10, 2014m01), administered services (2007m02), communication (2005m11, 2006m06, 2008m01, 2008m02, 2009m01, 2012m10, 2016m12, 2015m06, 2015m07, 2016m05, 2016m07), accommodation (2006m05, 2006m06, 2007m04, 2008m11, 2013m07, 2013m08, 2013m09, 2014m07, 2014m08, 2015m07, 2016m10, 2017m06, 2018m09).

We conduct an out-of-sample forecast evaluation exercise in order to simulate forecast errors as if they were generated in real time. Initially two-thirds of the sample (2005–2013) is used for the in-sample estimation, while one-third (2014–2018) is used for the out-of-sample forecast evaluation.

Latvia joined the euro area in January 2014, and since then Latvijas Banka regularly contributes inflation projections to the Eurosystem's Broad Macroeconomic Projection Exercise. In line with the Eurosystem's forecasting framework, euro area central banks develop their inflation projections based on a set of common assumptions (e.g. crude oil prices, DG AGRI prices and the exchange rate). As a result, we compile a database of each assumption at every time vintage used in the production of STIP forecasts to mimic forecast rounds in real time.

We closely follow Giannone et al. (2014) notation in setting up an evaluation exercise. First, let us define p_t as the natural logarithm of the consumer price index under consideration. Then the target variable is h-period ahead the change in prices as follows:

$$\pi_{t+h} = p_{t+h} - p_t \tag{3}$$

Each month we make projections 12 months ahead (horizon h) using the STIP model and store forecasts. Further, we compare forecasts with outturns and obtain the RMSFE as follows:

$$RMSFE_h = \sqrt{\frac{1}{K_h} \sum_{v=Jan2014}^{Dec2018-h} (\pi_{v,v+h} + \pi_{v+h})^2} \tag{4}$$

K_h is the number of forecast vintages between January 2014 and December 2018 for horizon h; $\pi_{v,v+h}$ is the change in prices for the date $v+h$ using vintage data v, and π_{v+h} is the observed change in prices h periods ahead.

We select AR(1) model as a benchmark model, which is frequently used in the literature:

$$\Delta y_t = a_0 + c_0 \Delta y_{t-1} + \epsilon_t \tag{5}$$

We produce three sets of forecasts: AR(1) aggregated approach, AR(1) disaggregated approach and STIP, where the first two used as benchmarks. We summarize the results of the forecast evaluation exercise in Table 7, where the ratio of forecast errors less than 1 indicates an improvement of STIP forecasts over disaggregated AR(1) model.

We find that the forecast errors of the STIP model are more accurate compared to both aggregated and disaggregated AR(1) benchmarks. Across broad components, the forecast accuracy gains are 20–30% forecasting 3 months ahead and 15–55% forecasting 12 months ahead. Note that the forecast errors are increasing along the forecast horizon, which is a standard result. It should be noted also that the highest forecast errors are observed in the food and energy components. The consumer prices of these components depend on the developments of global prices, which are highly volatile. In turn, the lowest forecast errors are in NEIG and services -- these consumer prices, to a large extent, are determined by domestic economic activity.

We check whether forecast accuracy is statistically different between the STIP and disaggregated AR(1) model using Diebold–Mariano (DM) test and find statistically significant

Table 7. Forecast errors for the STIP and AR(1) models.

	HICP	Unprocessed food	Processed food	Energy	NEIG	Services
STIP:						
3M	0.47	2.16	0.69	2.19	0.39	0.56
6M	0.69	2.66	1.18	3.16	0.46	0.79
12M	1.09	2.92	2.02	5.24	0.60	1.05
AR(1) aggregated:						
3M	0.66	–	–	–	–	–
6M	1.23	–	–	–	–	–
12M	2.39	–	–	–	–	–
AR(1) disaggregated:						
3M	0.69	2.57	0.96	2.62	0.39	0.54
6M	1.26	2.99	1.82	4.26	0.46	0.86
12M	2.41	4.37	3.47	6.98	0.69	1.58
Ratio (STIP / AR(1) disaggregated):						
3M	0.69	0.84	0.72	0.83	1.00	1.04
6M	0.55	0.89	0.65	0.74	1.01	0.93
12M	0.45	0.67	0.58	0.75	0.86	0.67
Modified DM test (t-statistics):						
3M	2.35***	3.05***	1.84**	1.70*	-0.02	0.17
6M	2.07**	1.60	1.70*	1.90*	-0.12	1.01
12M	1.55	2.67**	1.55	1.04	1.00	1.63*

Notes: The table reports forecast errors in terms of the RMSFE. The out-of-sample forecasting exercise is run from January 2014 to December 2018, while models are estimated from January 2005 through December 2013. We employ the DM test with a Harvey et al. (1997) correction (i.e. taking into account that forecast errors can be correlated among forecast horizons). *, ** and *** define statistical significance level at 10%, 5% and 1% respectively. We also cross-checked the statistical significance of difference in forecast accuracy using the Clark and West (2007) test and found that the results overall do not change the conclusion.

forecast accuracy improvements both for the headline inflation and several components (see Table 7 bottom panel). In the short horizon (3 months), the test indicates that the forecast errors of the STIP model are statistically significantly different from those of disaggregated AR(1) for unprocessed food, processed food and energy. In the longer horizon (12 months), the forecast errors of services and unprocessed food prices are statistically different from AR(1). In turn, the forecast errors of NEIG are not statistically significantly different from AR(1) model at any horizon. Note, however, that the level of the NEIG forecast errors is already quite low in the benchmark AR(1) model compared to other HICP components.

Forecast errors of all 33 HICP components are shown in Table 8. The results show that the forecast accuracy is greater for most components using STIP model compared to disaggregated AR(1) model. The forecast accuracy gains vary from 30% forecasting 3 months ahead to 60% forecasting 12 months ahead.

Table 8. Forecast errors of the HICP components.

	STIP			AR(1)			Ratio (STIP/AR(1))		
	M3	M6	M12	M3	M6	M12	M3	M6	M12
Headline HICP	0.47	0.69	1.09	0.69	1.26	2.41	0.69	0.55	0.45
Unprocessed meat	1.70	2.12	3.03	1.99	2.77	4.14	0.85	0.77	0.73
Unprocessed fish	3.85	4.24	5.50	4.62	6.08	9.02	0.83	0.70	0.61
Unprocessed eggs	3.88	4.78	6.95	3.96	4.76	6.98	0.98	1.00	1.00
Unprocessed fruits	3.78	4.24	4.69	4.37	4.58	6.38	0.87	0.93	0.74
Unprocessed vegetables	7.91	7.94	7.96	9.36	9.62	12.12	0.85	0.83	0.66
Processed meat	1.13	1.69	2.66	1.22	1.90	3.29	0.93	0.89	0.81
Processed fish	1.16	1.96	2.96	1.08	1.83	3.33	1.07	1.07	0.89
Processed fruits	2.27	2.90	3.49	2.53	3.26	4.36	0.90	0.89	0.80
Processed vegetables	4.17	6.01	8.14	4.64	6.42	8.54	0.90	0.94	0.95
Dairy	2.75	4.33	6.80	3.02	4.90	8.58	0.91	0.88	0.79
Cereals	1.01	1.44	1.94	1.22	2.16	3.78	0.83	0.67	0.51
Oils	2.93	4.72	7.98	3.10	5.04	8.31	0.95	0.94	0.96
Sugar	1.88	2.75	4.71	1.94	3.01	5.08	0.97	0.91	0.93
Other food	1.09	1.65	2.23	0.98	1.49	2.27	1.11	1.11	0.98
Drink	1.76	2.23	3.87	2.06	2.74	3.95	0.86	0.81	0.98
Alcohol	1.55	1.96	2.33	1.72	2.35	3.22	0.90	0.83	0.72
Tobacco	1.34	1.98	2.38	1.64	3.00	5.87	0.81	0.66	0.40
NEIG with domestic value added	0.44	0.58	0.75	0.63	1.07	1.85	0.70	0.55	0.40
Other NEIG	0.81	0.94	1.29	0.82	0.96	1.62	0.99	0.99	0.80
Administered NEIG	3.25	4.70	6.41	3.25	4.70	6.41	1.00	1.00	1.00
Market services	0.80	1.15	1.83	0.91	1.30	2.11	0.88	0.88	0.87
Catering services	0.81	1.20	1.39	0.57	1.02	2.07	1.43	1.18	0.67
Administered services	1.39	2.01	3.19	1.62	2.59	4.59	0.86	0.77	0.69
Communications	0.99	1.54	2.59	1.49	2.74	5.32	0.67	0.56	0.49
Accommodation	2.69	2.87	3.26	2.88	3.11	4.36	0.93	0.92	0.75
Education	1.05	1.41	1.67	1.05	1.41	1.67	1.00	1.00	1.00
Air transport	5.86	7.71	11.10	6.09	8.13	12.34	0.96	0.95	0.90
Package holidays	3.41	4.72	6.27	4.01	5.85	9.13	0.85	0.81	0.69
Car fuel	5.75	8.08	11.07	6.28	9.33	13.35	0.92	0.87	0.83
Natural gas	4.15	5.35	9.67	4.65	7.22	13.05	0.89	0.74	0.74
Electricity	5.78	8.26	11.56	5.78	8.26	11.56	1.00	1.00	1.00
Heating energy	2.59	4.51	8.98	3.19	5.95	11.19	0.81	0.76	0.80
Solid fuel	2.32	3.00	4.23	2.60	4.36	7.20	0.89	0.69	0.59

Notes: The table reports forecast errors of the STIP model and AR(1) model in terms of the RMSFE. Headline HICP of AR(1) relates to disaggregated approach. Consumer prices of water supply, education and electricity are largely administered and change infrequently, therefore STIP and AR(1) model projections are set unchanged (flat) over horizon. The out-of-sample forecasting exercise is run from January 2014 to December 2018. *, ** and *** define statistical significance level at 10%, 5% and 1% respectively. M3, M6 and M12 are projections 3, 6 and 12 months ahead respectively.

5. Conclusion

We build a short-term inflation projections (STIP) model for Latvia, currently used by the Bank of Latvia for ECB macroeconomic projection rounds. The model is based on ARDL framework, introducing long run relationships between consumer prices and their determinants, and a correction towards equilibrium. It employs disaggregated forecasting approach, dividing HICP into 33 components and making projections for each of them. In our model, consumer prices are affected by the four main factors. Crude oil prices are the main factor directly driving consumer prices of energy; and indirectly, through car fuel prices, affect consumer prices of food and some services. Global food commodity prices exert a pressure mainly on consumer prices of unprocessed and processed foods, which indirectly affect also consumer prices of catering services. The impact of nominal effective exchange rate (NEER) is mainly found in consumer prices of non-energy industrial goods (NEIG). Finally, domestic labour costs -- directly and indirectly -- affect almost all components of consumer prices.

We assess the forecast accuracy of the STIP model by running the real-time out-of-sample forecast exercise. For this purpose, we compile a database of each assumption at every time vintage used in the production of STIP forecasts to mimic forecast rounds in real time (over 2014–2018), while two-thirds of the sample (2005–2013) are used for the in-sample estimation. We find that consumer price forecasts of the STIP model are significantly more accurate compared to both aggregated and disaggregated AR(1) benchmarks. Across inflation components, the forecast accuracy gains are 20–30% forecasting 3 months ahead and 15–55% forecasting 12 months ahead.

Notes

1. The BMPE is a broad macroeconomic projection exercise conducted by the Eurosystem twice per year, while the NIPE is a narrow inflation projection exercise concomitant to the BMPE, but conducted four times per year over a shorter forecast horizon to monitor inflation developments. For details, see ECB, 2016.
2. Poland is a main exporter of meat products to Latvia accounting for more than a quarter of total meat imports over 2005–2018.
3. There is an anecdotal evidence that the bread baking industry in Latvia faces an ever-increasing competition from many small producers entering the market and from some supermarkets building their own bread baking facilities.
4. Note that petrol and diesel prices are the only HICP items whose prices are modelled in euro per litre rather than in logs. See Meyler (2009) on the merits of levels versus logs in the forecasting of car fuel prices.
5. This definition does not necessarily mean that these products are made in Latvia. The definition rather reflects the correlation with domestic labour costs, which might represent domestic value added of the good.
6. There is an anecdotal evidence that the number of large department stores and supermarkets increased markedly in Latvia during the last 15 years. Also, imports from China increased almost five times between 2005 and 2018.

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No potential conflict of interest was reported by the authors.

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Ethical approval

This article does not contain any studies with human participants or animals performed by any of the authors.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Appendix

Table A1. ADF unit root test results for the first differences.

HICP components	*p*-value	Lag length	Observations
Unprocessed meat	0.000	0	168
Unprocessed fish	0.000	6	168
Eggs	0.000	0	168
Unprocessed fruits	0.000	0	168
Unprocessed vegetables	0.000	0	168
Processed meat	0.001	3	168
Processed fish	0.000	1	168
Processed fruits	0.000	0	168
Processed vegetables	0.000	0	168
Dairy products	0.000	0	168
Bread and cereals	0.000	1	168
Oils and fats	0.000	2	168
Sugar and chocolate	0.000	2	168
Other food	0.000	0	168
Non-alcoholic beverages	0.000	0	168
Alcoholic beverages	0.000	0	168
Tobacco	0.000	0	168
Car fuel	0.000	0	168
Natural gas	0.000	0	168
Heat energy	0.000	0	168
Solid fuels	0.000	0	168
NEIG with domestic value added	0.001	3	168
Labour-intensive services[a]	0.000	1	168
Catering services[a]	0.000	0	168
Administered services	0.000	1	168
Communication services	0.000	0	168
Accommodation services	0.000	1	168
Air transport	0.000	0	168
Package holidays	0.000	0	168
Other variables			
DG AGRI cereals	0.000	2	168
DG AGRI dairy	0.000	1	168
DG AGRI total food	0.000	2	168
DG AGRI meat	0.000	0	168
Global sugar	0.000	1	168
Global coffee	0.000	0	168
Nasdaq salmon	0.000	0	166
NEER	0.004	9	168
Wage	0.009	3	163
Hotel occupancy rate	0.000	0	168
Internet usage	0.009	3	168
Timber	0.004	1	147
Oil, euro	0.000	0	732
Refined diesel	0.000	0	732
Refined petrol	0.000	0	732
Retail diesel	0.000	1	728
Retail petrol	0.000	1	728

Notes: Series are tested over the period 2005–2018. *P*-values below 0.05 indicate that the respective time series do not have a unit root in the first differences at 5% significance level. The lag length is selected based on the Schwarz information criterion. [a]Labour-intensive and catering services prices are tested using ADF test with breaking points in trend and intercept.

Table A2. Pesaran–Shin–Smith cointegration test results.

Equation	*F*-statistics	*I*(0) threshold	*I*(1) threshold
Unprocessed meat	11.53	3.88	4.61
Unprocessed fish	9.81	2.45	3.63
Eggs	12.01	3.79	4.85
Unprocessed fruits	9.47	3.88	4.61
Unprocessed vegetables	9.60	3.62	4.16
Processed meat	22.80	3.10	3.87
Processed fish	12.90	2.79	3.67
Processed fruits	9.74	3.79	4.85
Processed vegetables	7.44	3.62	4.16
Dairy products	12.83	2.79	3.67
Bread and cereals	22.64	3.88	4.61
Oils and fats	6.54	3.79	4.85
Sugar and chocolate	4.67	2.45	3.63
Other food	13.95	2.45	3.63
Non-alcoholic beverages	23.78	3.23	4.35
Alcoholic beverages	6.76	3.10	3.87
Tobacco	15.29	3.15	4.11
Refined diesel	9.58	3.62	4.16
Refined petrol	14.80	4.68	5.15
Retail diesel	16.91	3.10	3.87
Retail petrol	9.51	3.10	3.87
Natural gas	5.90	3.62	4.16
Heat energy	6.29	3.62	4.16
Solid fuels	10.37	2.72	3.83
NEIG with domestic value added	18.13	3.88	4.61
Labour-intensive services	20.91	4.68	5.15
Catering services	9.61	3.88	4.61
Administered services	28.06	4.68	5.15
Communication services	12.04	3.10	3.87
Accommodation services	14.31	3.88	4.61
Air transport	5.27	4.68	5.15
Package holidays	5.92	3.88	4.61

Notes: *F*-statistics greater than the *I*(1) threshold indicates that the variables in the particular equation are cointegrated.

Table A3. Results of serial correlation and heteroskedasticity tests.

	Serial correlation test		Heteroskedasticity test	
Equation	*F*-statistics	*p*-value	*F*-statistics	*p*-value
Unprocessed meat	1.50	0.23	0.90	0.50
Unprocessed fish	2.31	0.10	1.57	0.11
Eggs	1.42	0.24	3.34	0.00
Unprocessed fruits	0.06	0.94	0.79	0.64
Unprocessed vegetables	1.12	0.33	1.29	0.28
Processed meat	1.23	0.29	2.01	0.06
Processed fish	0.77	0.46	0.85	0.57
Processed fruits	1.21	0.30	1.07	0.39
Processed vegetables	3.68	0.03	1.16	0.31
Dairy products	1.89	0.15	0.36	0.97
Bread and cereals	0.36	0.70	2.72	0.00
Oils and fats	2.24	0.11	1.50	0.13
Sugar and chocolate	0.42	0.66	1.82	0.09
Other food	0.45	0.64	0.62	0.81
Non-alcoholic beverages	0.13	0.88	1.54	0.10
Alcoholic beverages	1.65	0.20	1.45	0.15
Tobacco	1.52	0.22	1.76	0.07
Refined diesel	0.21	0.81	18.85	0.00

(*Continued*)

Table A3. Continued.

	Serial correlation test		Heteroskedasticity test	
Refined petrol	0.53	0.59	1.80	0.07
Retail diesel	1.64	0.19	1.68	0.07
Retail petrol	0.13	0.87	1.78	0.04
Natural gas	0.16	0.85	0.11	1.00
Heat energy	1.89	0.15	1.10	0.36
Solid fuels	0.79	0.46	1.10	0.37
NEIG with domestic value added	0.78	0.46	1.04	0.41
Labour-intensive services	0.94	0.39	1.14	0.33
Catering services	0.78	0.46	3.66	0.00
Administered services	0.87	0.42	7.38	0.00
Communication services	0.31	0.74	0.98	0.48
Accommodation services	1.87	0.16	0.81	0.72
Air transport	0.44	0.65	4.48	0.00
Package holidays	0.48	0.62	3.72	0.00

Notes: We use the Breusch–Godfrey serial correlation LM test where the null hypothesis states that there is no serial correlation; in the Breusch–Pagan–Godfrey test used for heteroskedasticity, null states homoskedasticity.

Table A4. Models' in-sample explanatory power.

Equation	R^2 in levels	R^2 in differences	Observations
Unprocessed meat	0.9945	0.3376	168
Unprocessed fish	0.9912	0.4211	167
Eggs	0.9895	0.5596	168
Unprocessed fruits	0.9706	0.4846	168
Unprocessed vegetables	0.8253	0.2685	168
Processed meat	0.9965	0.3779	168
Processed fish	0.9988	0.5200	168
Processed fruits	0.9968	0.4321	168
Processed vegetables	0.9542	0.6692	168
Dairy products	0.9980	0.6723	168
Bread and cereals	0.9990	0.7243	167
Oils and fats	0.9974	0.5135	168
Sugar and chocolate	0.9959	0.1650	168
Other food	0.9987	0.4813	167
Non-alcoholic beverages	0.9977	0.5472	167
Alcoholic beverages	0.9956	0.5611	165
Tobacco	0.9997	0.9227	168
Natural gas	0.9979	0.6706	228
Heat energy	0.9989	0.6909	228
Solid fuels	0.9949	0.5844	150
NEIG with domestic value added	0.9983	0.6997	165
Labour-intensive services	0.9997	0.7981	165
Catering services	0.9996	0.8050	163
Communication services	0.9985	0.8127	166
Administered services	0.9990	0.5076	165
Accommodation services	0.9581	0.8576	168
Air transport	0.9326	0.1213	168
Package holidays	0.9574	0.1577	168
Refined diesel	0.9974	0.8132	732
Refined petrol	0.9908	0.5877	732
Retail diesel	0.9948	0.4520	728
Retail petrol	0.9934	0.5477	729

Notes: Refined (retail) diesel and petrol are weekly data, other variables are monthly data.

Table A5. Individual NEIG items, which are included in the aggregate 'goods with domestic value added' and other goods.

Goods with domestic value added:
Books
Spare parts and accessories for personal transport equipment
Other personal effects
Glassware and tableware and household utensils
Household textiles
Tools and equipment for house and garden
Newspapers and periodicals
Materials for the maintenance and repair of the dwelling
Other medical products, therapeutic appliances and equipment
Gardens, plants and flowers
Products for pets
Non-durable household goods
Electrical appliances for personal care, other appliances articles and products for personal care
Miscellaneous printed matter, stationery and drawing materials
Pharmaceutical products
Furniture and furnishings
Jewellery, clocks and watches
Carpets and other floor coverings
Other goods:
Motor cars
Motorcycles and bicycles
Information processing equipment
Telephone and telefax equipment
Photographic and cinematographic equipment and optical instruments
Recording media
Games, toys and hobbies
Equipment for sport, camping and open-air recreation
Garments
Clothing materials
Shoes and other footwear
Other articles of clothing and clothing accessories
Major household appliances whether electric or not and small electric household appliances
Equipment for the reception recording and reproduction of sound and picture

Table A6. Individual services items, which are included in the aggregate 'labour-intensive services'.

Labour-intensive services:
Actual rentals for housing
Services for the maintenance and repair of the dwelling
Other services relating to the dwelling n.e.c.
Repair of household appliances
Domestic services and household services
Insurance connected with the dwelling
Medical and paramedical services
Dental services
Financial services n.e.c.
Other services n.e.c.
Cleaning, repair and hire of clothing
Repair and hire of footwear
Repair of audio-visual photographic and information processing equipment
Veterinary and other services for pets
Recreational and sporting services
Cultural services
Hairdressing salons and personal grooming establishments
Maintenance and repair of personal transport equipment
Other services in respect of personal transport equipment
Passenger transport by sea and inland waterway
Insurance connected with transport