

INVESTMENT RESPONSES TO TAX POLICY UNDER UNCERTAINTY

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ONLINE APPENDIX

A INFORMATION ON DATA AND CLEANING

Table A.1 reports the impact of data cleaning procedures on the size of the analysis samples. Around 15% of the corporations were dropped because we suspect that in one of the years (within the period 2005 - 2016) they made a wrong entry in the VAT return. In our estimation samples, we only include mature firms, i.e. firms that are at least five years old in the post-reform period. Furthermore, to enhance comparisons between the treated and control firms we remove from the sample the largest 50% of the control group and the smallest 50% of the treated group, based on firm size in the last pre-reform period. Lastly, to reduce the risk that the treated group in the second experiment is populated by shrinking businesses (i.e. mid-sized firms in 2007 that became small in 2009), we impose a restriction on turnover change. Firms are excluded from the second experiment if their turnover changed between 2007 and 2009 by more than 40%. We use the analogous condition for the first experiment, with regard to change in turnover between 2005 and 2006. The last column of the table refers to the samples used in the main analyses.

Table A.1. Population of firms

Sample	Number of firms	After dropping unincorporated businesses	After dropping implied data errors	After dropping firms treated in 2008	After dropping young firms	After dropping smallest and largest firms	After dropping firms with large turnover changes
2006-2007	1,396,856	107,184	91,212	-	62,453	31,227	21,008
2008-2010	1,565,077	127,313	107,548	50,730	29,801	14,900	10,755

Generally, VAT returns are verified by tax inspectors and should be accurate. Nevertheless, we use input VAT tax related to investment, as well as firm's turnover, to

detect observations which may be erroneous. Then we drop all observations for firms that record at least one data error.

Some firms are not VAT taxpayers, and therefore they cannot be included in the analysis. Product-based VAT exemption is applicable mainly to financial services, health care and education. Entity-based exemption is available for very small firms below an annual turnover threshold, which remained very low during the period of analysis.¹

Apart from investment and turnover, the data on international trade also comes from VAT returns. The exception is extra-EU import, which is added from the customs data. We also merge the VAT data with CIT to gather data on firms' profits and losses.

Further, we take advantage of the register of economic activity to obtain more information at the firm-level. First, the type of entity is used to drop non-businesses from the VAT data. Second, year of registration allows us to distinguish between start ups and established firms. Third, we use the NACE classification code to define sector dummy variables and the continuous treatment measures. The drawback of the data obtained from the company register is that it only reflects recent information, without tracking the historical changes in the firms' classification.

B INSTITUTIONAL DETAILS

Both reforms that we use for identification in our paper apply to expenditure on plant and machinery. Buildings, cars and intangibles are excluded. This is useful in our context as there may be profit-shifting motives in the case of acquisition of intangible assets. In the VAT returns, firms are obliged to declare the investment amount that is associated with any input VAT. Although it excludes some types of investment such as real estate, it covers most of the fixed assets and intangibles.

The first reform was announced when the policy was finalised and enacted in November 2006. The accelerated depreciation then started applying to investment incurred on or after 1 January 2007. We therefore rule out anticipation effects that could have led firms to postpone investment. The late announcement of the policy is especially important for our classification of firms into treatment and control, because it also meant that firms could not try to manipulate their turnover in 2006. To our knowledge, there were no plans or preparation of a second reform, which was adopted to respond to the global economic downturn.

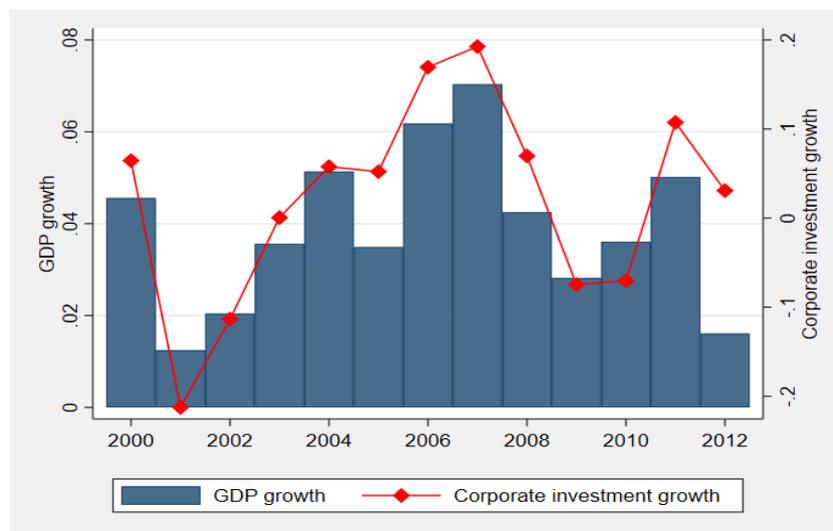
¹During the analysis period, this exemption threshold never exceeded 150,000 PLN, which is well below the neighborhood of the turnover thresholds that we are using in our quasi-experiment.

C MACROECONOMIC CONDITIONS DURING THE SAMPLE PERIOD

The first reform was introduced during a peak in the business cycle. In 2006, the Polish GDP growth exceeded 6% and corporate investment grew by almost 17% (Figure C.1). The second reform, on the other hand, was introduced to respond to the global financial crisis. Although Poland avoided recession during the 2008-2009 period, economic growth was significantly dampened. Aggregate corporate investment decreased in 2009 and 2010, each year by around 7%.

In advanced economies such as the US and the UK, bank lending dropped substantially in the global liquidity crisis (Ivashina and Scharfstein, 2010). In Poland, partly thanks to a less developed financial system in the pre-crisis period, bank lending did not suffer from the global credit crunch to the same extent as in most advanced economies (Drozdowicz-Biec, 2011).

Figure C.1. Macroeconomic developments, 2000-2012



Note: Annual growth rate of gross fixed capital formation of non-financial corporations is plotted on the right axis. Annual GDP growth is plotted on the left axis. Source: Eurostat.

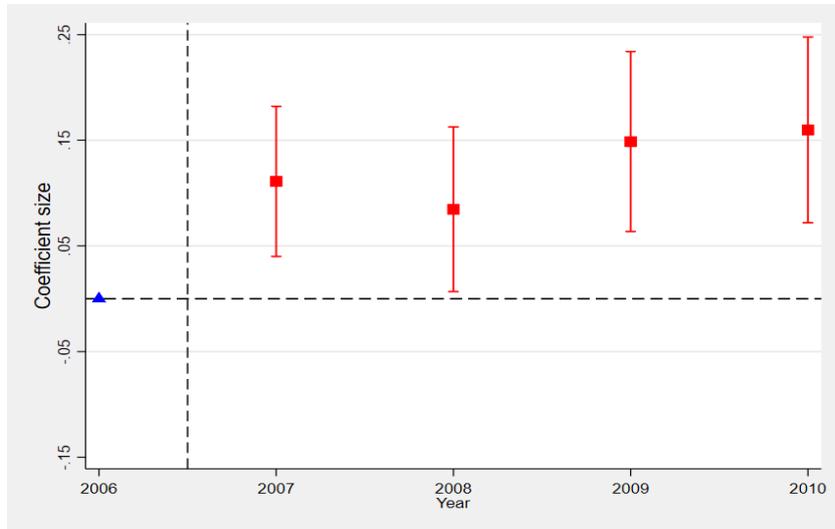
D FURTHER ROBUSTNESS

D.1 AVERAGE INVESTMENT PATTERNS

Average investment patterns across years before and after the reform are useful for a variety of reasons. For the pre-reform period, estimated year-by-year coefficients allow us to examine common trends between treated and control groups. For the post-reform period, to the extent that investment responses demonstrate significant changes over the years, we may observe delayed responses due to learning about the policy or adjustment costs.

In Section 5.1, we show that average investment for treated and control groups follow common trends in the pre-reform period for both samples. In Figure 7, treated firms clearly increase their average investment after the reform, while Figure 8 shows that there is no clear differential increase in investment of treated firms after the reform in the high volatility period. In Figure D.1 and Figure D.2, we estimate year-by-year coefficients on $\text{Treatment} \times \text{Post-reform}$ for the first and the second reform period, respectively. The error bars represent 95 percent confidence intervals.

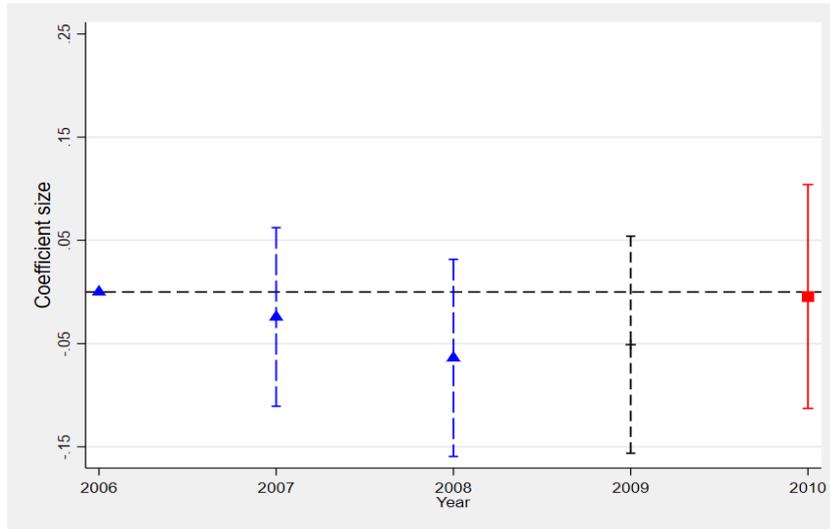
Figure D.1. Year-by-year investment patterns, low volatility period



Note: This figure presents the point estimates with 95% confidence intervals for the γ_k coefficients from the regression specification: $I_{it} = \sum_{k=2006}^{2010} \gamma_k D_i T_k + \eta_i + \delta_t + X'_{it} \beta + \psi_{st} + \varepsilon_{it}$, where D_i is a dummy variable that takes the value unity for treated firms and zero otherwise, T_t is a dummy variable that takes the value unity only for one period, that is, year k , and zero otherwise, η_i represent firm fixed effects, δ_t represent year fixed effects. We normalise $\gamma_{2006} = 0$. Blue dashed error bars and triangles represent the point estimate and confidence intervals for pre-reform years and the red solid error bars and squares represent the point estimate and confidence intervals for post-reform years.

In the low volatility period, adjustment to the new average investment level appears swift and stable. This pattern in the low volatility period indicates that issues related

Figure D.2. Year-by-year investment patterns, high volatility period



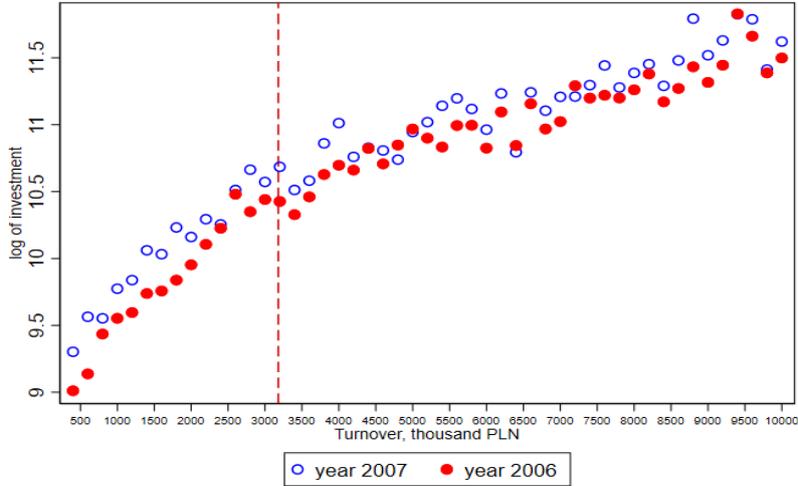
Note: This figure presents the point estimates with 95% confidence intervals for the γ_k coefficients from the regression specification: $I_{it} = \sum_{k=2006}^{2010} \gamma_k D_i T_k + \eta_i + \delta_t + X'_{it} \beta + \psi_{st} + \varepsilon_{it}$, where D_i is a dummy variable that takes the value unity for treated firms and zero otherwise, T_t is a dummy variable that takes the value unity only for one period, that is, year k , and zero otherwise, η_i represent firm fixed effects, δ_t represent year fixed effects. We normalise $\gamma_{2006} = 0$. 2009 is a partial treatment year and therefore marked with black dashed bars. Blue dashed error bars and triangles represent the point estimate and confidence intervals for pre-reform years and the red solid error bars and squares represent the point estimate and confidence intervals for post-reform years.

to low take-up to account for our results in the high volatility period are unlikely for incorporated businesses. This is in line with the evidence from the US that Kitchen and Knittel (2016) show in relation to special depreciation provisions.

Zooming in on the different size groups within each sample, in Figures D.3 and D.4, we plot average investment across 200,000 PLN (approximately 50,000-Euro) turnover bins for the pre-reform and the post-reform periods. In the low volatility period, treated firms (below the size threshold for eligibility) experience a hike in average investment between the pre-reform year of 2006 and the post-reform year of 2007 for virtually all treated size bins that we show in this graph. This jump is much smaller for average investment of firms in size bins that are larger than the threshold turnover size that applies in the first reform period.

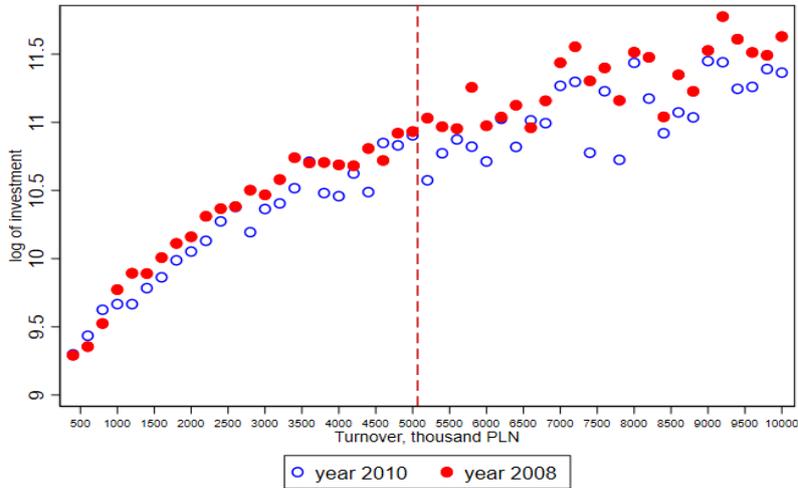
In contrast to Figure D.3, we do not observe any increase in investment for treated firms in the second reform period (Figure D.4). If anything, we observe a drop in average investment from 2008 to 2010 for all size bins that we depict in the high volatility period. We hypothesize that the weaker policy impact is due to increased uncertainty, and we show evidence that supports this hypothesis in Section 5.

Figure D.3. Average investment by size groups, low volatility period



Note: This graph plots average investment for companies across 200 thousand PLN turnover bins in the last pre-reform period and the first post-reform period. The pre-treatment values are represented by red dots and the post-treatment values are represented by blue circles. The reference turnover ranges are based on 2006, which is the statutory reference year to determine eligibility to treatment.

Figure D.4. Average investment by size groups, high volatility period



Note: This graph plots average investment for companies across 200 thousand PLN turnover bins in the last pre-reform period and the first post-reform period (excluding the partial treatment year 2009). The pre-treatment values are represented by red dots and the post-treatment values are represented by blue circles. The reference turnover ranges are based on 2009, which is the statutory reference year to determine eligibility to treatment.

D.2 INSTRUMENTAL VARIABLES REGRESSION FOR THE HIGH VOLATILITY PERIOD

We now implement an instrumental variable (IV) strategy to account for any changes in firm size and the possibility of an interaction with the implementation of the first reform. We first assign simulated treatment using the thresholds for the second reform on firm size in the last period before the implementation of the first reform, in 2006. We use this simulated treatment variable as an instrument for treatment in the second reform period. In Table D.1, we present the first stage regression result with the true treatment dummy variable as dependent variable in Column (1) and we present the second stage result with the log of investment as dependent variable in Column (2). Finally, Column (3) replicates the results from the preferred specification in Table 4 for reference. Using our IV strategy, the coefficient on Treated \times Post 2009 using two-stage least squares is estimated to be 2 percent and statistically insignificant.

Table D.1. Using pre-first-reform turnover as instrument for eligibility to second reform

Period: Specification: Dep.var:	High vol. IV first stage Treatment dum. (1)	High vol. IV second stage $\log I_t$ (2)	High vol. Baseline, preferred $\log I_t$ (3)
Treated \times Post 2009		0.020 (0.088)	0.064 (0.059)
Simulated Treatment	0.597*** (0.010)		
Turnover control (lagged, in log)?	Yes	Yes	Yes
Turnover control (quart. dummies)?	Yes	Yes	Yes
Firm fixed effects?	Yes	Yes	Yes
Year effects?	Yes	Yes	Yes
Sector-year effects?	Yes	Yes	Yes
Exporter-year effects?	Yes	Yes	Yes
Importer-year effects?	Yes	Yes	Yes
No of observations	15773	15773	15779
No of treated firms	1984	1984	1984
No of control firms	5601	5601	5601

Note: In this table, Column (1) shows the first stage result from an instrumental variables strategy in which we instrument the actual treatment status with a simulated treatment dummy that uses turnover from 2006 rather than the turnover from 2009 based on the threshold for eligibility as defined in 2009. Column (2) shows the second stage results and Column (3) shows the baseline result from the preferred specification. The result in Column (3) is the same as that in the main text, Table 4, Column (4).

D.3 ANALYSIS USING QUARTERLY DATA

As another robustness check, we use high frequency data to exploit the timing of changes in the treatment status within the second experiment. Recall that the eligibility turnover threshold was increased in two steps. First, the EUR denominated threshold was raised in May 2009. The PLN denominated threshold was further increased in January 2010 due to the currency depreciation that occurred after October 2008. In our baseline analysis, we drop year 2009 and analyse the investment response to treatment only in 2010.

In the analysis below, the post-reform period consists of the second half of 2009 and the entire 2010. The pre-reform period covers 2008 and the first quarter of 2009. The firm treatment status is consistent with the contemporary rules of the Lump Sum Depreciation scheme. We use the same sample of firms as in the baseline second experiment. Therefore, none of these firms was treated in 2008. If a firm is treated in the first quarter of 2009, we code this single quarterly observation as missing.

Quarterly analysis is not our preferred approach because of many observations for which investment equals zero. In the period of the second experiment, non-zero observations constitute only 38% of the treated sample and 55% of the control group sample. The zeros may distort interpretation of the intensive margin analysis. We therefore focus on Poisson regressions that takes into account both intensive and extensive margin effects.²

The results are consistent with the findings from the annual analysis. In the environment of high uncertainty, the investment response of more exposed firms is indistinguishably different from zero, while less exposed firms respond strongly to the policy.

²Consider an example, where a firm invests 25 dollars in each quarter in a pre-reform year and 50 dollars in only two quarters in a post-reform year. Our preferred approach in this analysis therefore retains the zero values.

Table D.2. Quarterly analysis of investment responses

Sample	Low vol.	High vol.	High vol.
Dep.var: I_t	(1)	(2)	(3)
Treated \times Post Reform	0.113*** (0.037)	0.089** (0.039)	0.128*** (0.046)
Treated \times Post Reform \times High Exposure			-0.092 (0.081)
Post Reform \times High Exposure			-0.060* (0.036)
Turnover control (lagged, in log)?	Yes	Yes	Yes
Turnover control (quart. dummies)?	Yes	Yes	Yes
Firm fixed effects?	Yes	Yes	Yes
Period effects?	Yes	Yes	Yes
Exporter-/importer cont.?	Yes	Yes	Yes
No of observations	78551	71913	71913
p-val. Coeff. on Treated \times Post Reform \times High Exposure + Coeff. on Treated \times Post Reform = 0			0.598

Note: In this table, we present the results of Poisson regressions on the quarterly samples. Extreme values of dependent variable I_t in levels are winsorised above the 95-th percentile value. In Column (1), we report results for the first experiment sample. In Column (2), we use the second experiment sample, where pre-reform period consists of 5 quarters (up to the first quarter of 2009) and the post-reform period covers 6 quarters (starting in the third quarter of 2009). Column (3) adds interaction with the exposure to uncertainty, similarly as in Table 4. p -value in the bottom row of this table represents the result of a test of the hypothesis that the sum of the coefficients on (Treated \times Post Reform \times High Exposure) and (Treated \times Post Reform) is equal to zero.