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## Not coming in today - firm productivity differentials and the epidemiology of the flu

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# IAB-DISCUSSION PAPER

Articles on labour market issues

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**6|2020** Not coming in today - Firm productivity  
differentials and the epidemiology of the flu

Matthias Dorner, Peter Haller

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# Not coming in today - Firm productivity differentials and the epidemiology of the flu

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Peter Haller (IAB)

Mit der Reihe „IAB-Discussion Paper“ will das Forschungsinstitut der Bundesagentur für Arbeit den Dialog mit der externen Wissenschaft intensivieren. Durch die rasche Verbreitung von Forschungsergebnissen über das Internet soll noch vor Drucklegung Kritik angeregt und Qualität gesichert werden.

The “IAB-Discussion Paper” is published by the research institute of the German Federal Employment Agency in order to intensify the dialogue with the scientific community. The prompt publication of the latest research results via the internet intends to stimulate criticism and to ensure research quality at an early stage before printing.

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## Abstract

With more than four million cases in Germany every year, influenza and acute upper respiratory tract infectious diseases (henceforth URTI) exhibit the highest number of reported doctor consultations. Although the direct treatment costs for URTI are comparably low, the indirect economic costs, due to work absences and productivity impairments of sick workers who remain at work (presentism), are far more compelling. In this paper, we estimate the effect of local URTI incidences as an exogenous shock to the production factor labor and thus on firm productivity. To quantify the URTI related shock on the production factor labor, we scrape a large number of weekly maps depicting the (local) URTI index across Germany, which are provided in the official influenza surveillance system. Measured by the length of the influenza season in German municipalities from 2003 to 2009, these data exhibit substantial seasonal as well as regional variation. In our main analysis, we estimate firm level production functions using data from the IAB Establishment Panel, a comprehensive German firm survey. In our main regression, we analyze total factor productivity differentials and their relationship with the local influenza intensity. We find sizeable negative effects of the URTI diseases on firm productivity. We attribute this effect to a combination of direct productivity losses caused by absences of sick workers as well as indirect productivity impairments due to presenteeism.

## Zusammenfassung

Mit mehr als vier Millionen Fällen pro Jahr in Deutschland nehmen Influenza und akute Infektionskrankheiten der oberen Atemwege (URTI) die Spitzenposition unter den gemeldeten Arztbesuchen in Deutschland ein. Obwohl die direkten Behandlungskosten vergleichsweise niedrig sind, sind die indirekten wirtschaftlichen Kosten aufgrund von Fehlzeiten und Produktivitätseinbußen bei kranken Arbeitnehmern, die am Arbeitsplatz verbleiben (Präsentismus), weitaus bedeutsamer. In diesem Papier schätzen wir den Einfluss lokaler URTI-Inzidenz als exogenen Schock für den Produktionsfaktor Arbeit und damit für die Produktivität von Firmen. Um den Schock auf den Produktionsfaktor Arbeit zu quantifizieren, extrahieren wir aus einer großen Zahl an Karten aus dem offiziellen Grippe-Überwachungssystem den lokalen URTI-Index. Bezogen auf die Dauer der Grippesaison in deutschen Gemeinden von 2003 bis 2009 zeigen unsere Daten erhebliche saisonale und regionale Schwankungen. In unserer Analyse schätzen wir Produktionsfunktionen auf Unternehmensebene anhand von Daten aus dem IAB-Betriebspanel. In unserer Hauptregression analysieren wir Produktivitätsunterschiede und deren Zusammenhang mit der lokalen URTI-Intensität in einem Jahr. Wir finden negative Auswirkungen von URTI auf die Produktivität von Unternehmen. Wir führen diesen Effekt auf eine Kombination aus direkten Produktivitätsverlusten durch Fehlzeiten kranker Mitarbeiter sowie indirekten Produktivitätseinbußen durch Präsentismus zurück.

JEL

L25, I12, J24, R1

## Keywords

flu, productivity, regional

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# 1 Motivation

In many countries, the months November to March are notoriously famous as flu season. Every year the incidences of influenza-like acute infectious illnesses of the upper respiratory tract (henceforth URTI) are rising. The viral infection can be dangerous of children and older persons. For all other age groups, it is a tedious disease from which the individual usually recovers within a week. Yet, the incidences of the seasonal URTI differ in their exact timing, intensity and in their local occurrence. Regardless of their specific type, the direct treatment costs of URTI are comparably low for high-income countries (see de Francisco et al., 2015). Cost estimates for the US range between \$6 to \$25 billion (Putri et al., 2018; Molinari et al., 2007). Due to the rapid occurrence and short course of the disease the indirect effects through productivity losses are far more compelling. Bramley/Lerner/Sarnes (2002) splits these losses into one third that is attributed to work absences and two thirds that are due to productivity losses caused by presenteeism (i.e. work while sick). Survey data for the US on workers who suffer from influenza suggest a decay in individual productivity of about one third (Dicpinigaitis et al., 2015). The costs for Germany are documented in various official statistics: With over seven million reported cases in 2012, the influenza-like diseases have the highest number of reported doctor consultations. The average absence from work in 2012 of seven days (see Bundesministerium für Gesundheit, 2014), adds up to a loss of the input of around 55,000 full-time equivalent sick-leave per year. A firm can usually hardly adjust its human resources immediately as a direct response to clustered incidences of URTI induced absences, leading to a decrease in the production of goods and services of a firm. Presenteeism is also documented in Germany. According to a survey of DAK-Gesundheit (2016), more than 50 percent of the workforce have worked during the last 12 months despite feeling sick. The literature further highlights, that both volume and costs of presenteeism are higher than for actual absences (see Oldenburg, 2012; Steinke/Badura, 2011).<sup>1</sup>

Lacking of precise firm level data on sickness related absences from work, we are the first to exploit weekly (geographic) data from the official influenza surveillance system in Germany to analyze the empirical relationship between the intensity of the influenza season in German municipalities and differentials in the productivity of firms. The nexus between firm productivity and the intensity of the influenza season originates in the location of the firm and the fact that high intensity of influenza represents an exogenous shock to the firm via disproportional high absences of employees from work and productivity impairment of employees due to presenteeism. Using URTI intensity as an exogenous shock enables use to estimate the causal effect of labor on firms' productivity.

A healthy labor force can be seen as a prerequisite for long-term investments into human capital accumulation Becker (1962), thus a driver for productivity growth. Empirically, the long

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<sup>1</sup> A comprehensive survey on presenteeism in Germany and other countries is Steinke/Badura (2011).

term effects of illnesses on productivity focuses more on chronic diseases or large pandemic shocks (e.g., Percoco, 2016). In general, illnesses reduce individual productivity before as well as after the actual sickness period (Brouwer et al., 2002). To prevent pandemic outbreaks flu vaccinations are recommended, including older individuals and employees in the service industry with frequent customer contact (Maurer, 2009). With regards to short-term interruptions of the input-factor "labor" through influenza-like diseases flexible sick-pay schemes are common. It allows employee to nurse a cold and return quicker to work. However, it also poses a threat of moral hazard. Studies show that productivity gains through sick-day leave outweighs losses through presenteeism or moral hazard (Lohaus/Habermann, 2019; Pichler/Ziebarth, 2017). In any case, short-term and unforeseeable incidences of URTI interrupt labor supply, thus firm's short-term productivity.<sup>2</sup>

From official statistics or firm-level data the effects through short-term absenteeism are hard to investigate. The statutory health insurance system<sup>3</sup> in Germany is an admired institution built upon many different insurance companies with partly locally independent affiliated firms. This makes it merely impossible to set up a comprehensive database covering the number of doctor consultations with influenza-like illnesses by regions. Post-season influenza season surveys are expensive to conduct. The official employment data only records statutory sick pay after six weeks of absence due to sickness. The pension insurance is limited to information about permanent occupational disability. Against this backdrop, several countries around the globe have established health monitoring systems targeting on URTI in general and influenza in particular. In Germany, the organization in charge for the monitoring system is the Robert-Koch Institute (RKI), which is a federal institute within the Federal Ministry of Health. Within this organisation a influenza working group established a comprehensive monitoring system of the epidemiology of the influenza-like illness following international epidemiological standards. An index documenting the (local) URTI situation in Germany draws on the voluntary reporting of 700 to 900 medical offices around Germany. This index and further indicators in the monitoring system are important for public health management of URTI in Germany.

We propose a stepwise empirical approach in which we first estimate the total factor productivity (TFP) of a firm using a simple Cobb Douglas production function framework. In our main analysis, we regress the (annual) estimate of TFP on the local influenza intensity in the same year and a rich set of controls to obtain the causal effect of the influenza on productivity. Our findings suggest that influenza-like diseases via their seasonal intensity indeed affect productivity differentials across firms. Our preferred specification, which controls for firm

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<sup>2</sup> Many studies rely on reported doctor consultations, which implies the estimated effects of flu and cold on productivity to be the lower limit. Though, there are other attempts to capture the true exposure in the population. Famously until 2015, Google Flu Trend established a flu monitoring based on search queries, which proved inadequate in pandemic outbreaks driven by people searched for information about the disease (Lazer et al., 2014; Butler, 2013; Cook et al., 2011).

<sup>3</sup> In 2015, 86 percent of the population were covered by the statutory insurance.



and regional heterogeneity suggests that a marginal increase in the intensity of the influenza season reduces the TFP of local firms by about 1.3 percentage points, relative to comparable firms in other locations. The remainder of the paper is as follows: In section 2 we illustrate our theoretical motivation building on a production function framework. We present the data in chapter 3, followed by descriptive evidence in section 4. The results are presented in 5. Section 6 concludes.

## 2 Theoretical motivation & Empirical Approach

We investigate the effect of local influenza activity on total factor productivity of a firm using a standard production function framework, firm level data and a rich set of controls. The basic rationale driving our research is that firms and their workforce by their location are exposed to the local influenza and URTI activity (standardized by the expected level of URTI in the location), which, at the annual level, leads to a relative shock on the production factor labor and the TFP of the firm. Given the epidemiology of the flu, we argue that the shock on the firm is exogenous because neither firms nor individuals can anticipate the local occurrence and seasonal timing of the flu. Also, neither firms nor workers are able to directly adjust their production function or their behavior in response to a local influenza shock.

Following a standard production function approach, the quantity of output ( $Q$ ) of a firm is expressed as a function of a set of different inputs available to a firm such as labor ( $L$ ), capital ( $K$ ) and other tangible or intangible factors ( $M$ ) (e.g., land, intermediate goods, raw materials, knowledge). Mathematically, the basic relationship between inputs and outputs can be written as follows:

$$Q = f(L, K, M) \tag{2.1}$$

In our case, we assume only two inputs, labor and capital, which in a simple Cobb-Douglas production function equation with constant returns to scale are denoted as follows:

$$Y = AL^\alpha K^{1-\alpha} \tag{2.2}$$

In equation 2.2,  $Y$  represents output,  $L$  and  $K$  represent the production factors labor and capital and  $A$  the total factor productivity (TFP).  $\alpha$  and  $\beta$  denote the output elasticities, which are determined by factors such as the production technology or organization of the firm. Capital and labor are to some extent substitutes and complements. The latter gives rise to potential scale economies. In the first stage of our analysis, we use the Cobb Douglas production function framework in a log linearized form to estimate TFP for each firm  $i$  in each year  $t$  using

OLS.<sup>1</sup>

$$\ln(Y_{it}) = A_{it} + \alpha \ln(L_{it}) + (1 - \alpha) \ln(K_{it}) + \psi_t \quad (2.3)$$

$$A_{it} = \ln(y_{it}) - \widehat{\ln(y_{it})} \quad (2.4)$$

Departing from these first stage estimates of TFP, in our second stage and main analysis, we regress  $A_{it}$  on the local flu intensity ( $FLU_{rt}$ ), a set of firm level control variables ( $\gamma_{it}$ ), municipality level controls ( $\theta_{rt}$ ), as well as on municipality ( $\sigma_r$ ) and time ( $\phi_t$ ) fixed effects. The main regression equation is:

$$A_{it} = \beta FLU_{rt} + \gamma_{it} + \theta_{rt} + \sigma_r + \phi_t + \epsilon_{it} \quad (2.5)$$

With  $FLU_{rt}$  indicating the municipal intensity of the flu season in year  $t$  to which the localized firm  $i$  is exposed,  $\beta$  represents our main effect of interest. Given the nature of the flu and its epidemiology, we argue that it is exogenous to the local firms and it affects the production factor labor randomly by reducing the volume of labor that the firm may exploit to produce goods and services. Assuming imperfect substitution of labor through capital and cost of capital, the flu appears as an exogenous random shock to a firms' production function.

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<sup>1</sup> Estimating TFP using OLS is likely to result in biased estimates because productivity and input choices are likely to be correlated, which results in an endogeneity problem. The literature proposes a number of ways to deal with these issues, e.g. by using firm fixed effects or instrumental variable approaches (see survey by Van Beveren (2012)).

## 3 Data

**Influenza data.** In order to measure the shock to the production factor labor, we build on data provided by the Arbeitsgemeinschaft Influenza (influenza working group, AGI). This community established a comprehensive monitoring system of the epidemiology of the influenza and other acute respiratory diseases in Germany following international epidemiological standards. From 2001, the Robert Koch Institute (RKI) has lead the surveillance system. The RKI is a federal institute within the Federal Ministry of Health. One of the main tasks of the organization is the safeguarding of public health in Germany. The purpose of the monitoring is the establishment of a sound database to draw evidence-based inference for the management of URTI. The index, which is exploited to construct our measure of local URTI intensity draws on the voluntary reporting of 700 to 900 medical offices<sup>1</sup> around Germany (see Figure A1)<sup>2</sup>. The AGI publishes from the end of September until the beginning of April in each year a weekly map of an index based on doctor consultations related to URTI. This URTI index is standardized by the local supply and demand for medical treatment (i.e. demographic factors, types of medical offices) and thus can be used for regional comparisons (see Uphoff, 1998). An example of a weekly map is depicted in Panel (1) of Figure 1 (AGI Influenza, 2019). Towards constructing our final indicator, which covers the influenza seasons 2003 until 2009 for all municipalities in Germany, we georeference all weekly maps that are available as raster data and extract the color values for each pixel. The color scale ranges from ‘blue’ (normal relative intensity) to ‘red’ (very high relative intensity). We define five categories based the range of colors in the map. The highest levels URTI four and five (i.e. dark orange and red) represent the class of high URTI intensity pixels, while we discard other categories for our main indicator. In the next step, we assign the URTI intensity (pixel data) to municipalities (vector data) using overlay methods in a geographical information system. We fully classify a municipality at a weekly basis as highly exposed to URTI if at least 80 percent of all pixels that intersect in the GIS with its municipal area fall into category four or five. We perform these steps for all weekly maps published by the RKI between 2003 and 2009. Departing from these weekly data at the municipality level, we generate two indicators : First, the total weeks with extraordinarily high URTI occurrence by municipality and calendar year. Second, the relative flu intensity, which is the percentage of weeks with extraordinarily high URTI intensity relative to the full influenza season in a calendar year.

**Firm Level Data.** We use the IAB Establishment Panel survey (IAB-EP), the largest firm survey in Germany to assess the effect of URTI on firm productivity. The IAB-EP is a standardized firm survey administered by the IAB that is conducted annually since 1988 (Fischer et al., 2009; Ellguth/Kohaut/Möller, 2014). The survey includes a set of questions that are of relevance for

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<sup>1</sup> The number varies every year, which should be uncorrelated with the local incidences of URTI.

<sup>2</sup> Per definition, the indicator monitors only doctor consolidations, hence, not the full extent of URTI in the population. An enhancement of the index with survey data of the total population was set up in 2011.

our analysis, which were prepared using the syntax provided in Umkehrer (2017). First, we exploit information on the production value, i.e. output of the firms as reported in the survey. Second, we use investment data (total investments, indicators for different types of investments) and perpetual inventory calculations to approximate the firm's capital stock in the absence of actual capital stock information in the survey (for a description of the methodology, see (Müller, 2008, 2010)). Using the link of the survey to other entirely register based establishment level data at the IAB, we enrich the survey with information on total employment, NACE industry codes and structural characteristics of the workforce (e.g., share of local workforce, age structure, education structure). These variables are measured on June 30 in each year and are used as control variables in our main regression (Equation 2.5). We estimate the production function (Equation 2.3) drawing on deflated<sup>3</sup> gross value added and capital stock information from the survey, as well as on the number of workers merged on June 30 from the employment register. We also use NACE industry codes available from the register to restrict our analysis sample to manufacturing firms only.

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<sup>3</sup> Deflation to the year 2010 using the producer price index information available from the Federal Statistical Office of Germany.

## 4 Descriptive Analysis

The intensity of URTI varies from season to season. In Table 1, we report in the left panel the seasonal intensity in all German municipalities and in the right panel of the Table 1, the municipalities that are represented with at least one firm in our final analysis sample. What is striking is the outstanding URTI activity in the year 2009. On average, a municipality in this year suffered from almost 7 weeks of high URTI intensity (out of a total season length of 27 weeks), while in 2004 and 2008, only few municipalities experienced remarkable relative local influenza activity peaks. Apart from that, it seems that every two years the intensity increased, i.e. a high intensity year is followed by a low-intensity year. Overall, our analysis sample (right panel) seems to follow the general pattern of all German municipalities (left panel).

**Table 1: URTI intensity (weeks with outstanding URTI activity) by year**

	All municipalities					Municipalities in sample				
	Mean	Std.dev.	Min.	Median	Max.	Mean	Std.dev.	Min.	Median	Max.
2003	2.30	1.07	0	2	6	2.27	1.03	0	2	6
2004	0.14	0.39	0	0	5	0.07	0.29	0	0	3
2005	4.92	1.50	0	5	9	4.91	1.19	0	5	9
2006	0.03	0.19	0	0	3	0.04	0.22	0	0	2
2007	2.88	1.87	0	3	8	3.64	2.13	0	3	8
2008	0.39	0.82	0	0	8	0.29	0.74	0	0	5
2009	6.84	2.14	0	7	18	6.70	2.08	1	7	15

Source: Own calculations.

In Table 2, we describe the variables that are used in our main regression. First, we find that our TFP estimate is highly skewed, which is typical for productivity data (see Syverson, 2011). The other variables describe the controls at the local and at the firm level. For instance, municipality population density and demographics matter for the epidemiology of URTI. Even more important are the firm level controls, which include the median wage as a proxy for the labor productivity in the firm and a set of other structural characteristics of the workforce such as shares for the skill and age groups. The skill groups capture the different types of jobs in a firm and their complexity, and thus potential substitutability. The age of the workforce helps to account for differentials in the risk of exposure to URTI as well as for the correlation between the length of sickness related of absences and age. In addition, firms might be able to react more flexibly to a significant influenza outbreak by, e.g., using overtime to cope with the absence of important workers. Health management measures might help the firms to better mitigate to health related shocks or better prevent outbreaks that are significant.

In Figure 1, we present four maps to clarify our empirical approach. First, we find in panel (1) the base map on which our URTI intensity measure is built (see Influenza, 2019). As an example, we depict the map of influenza activity in calendar week 8/2009. The values from

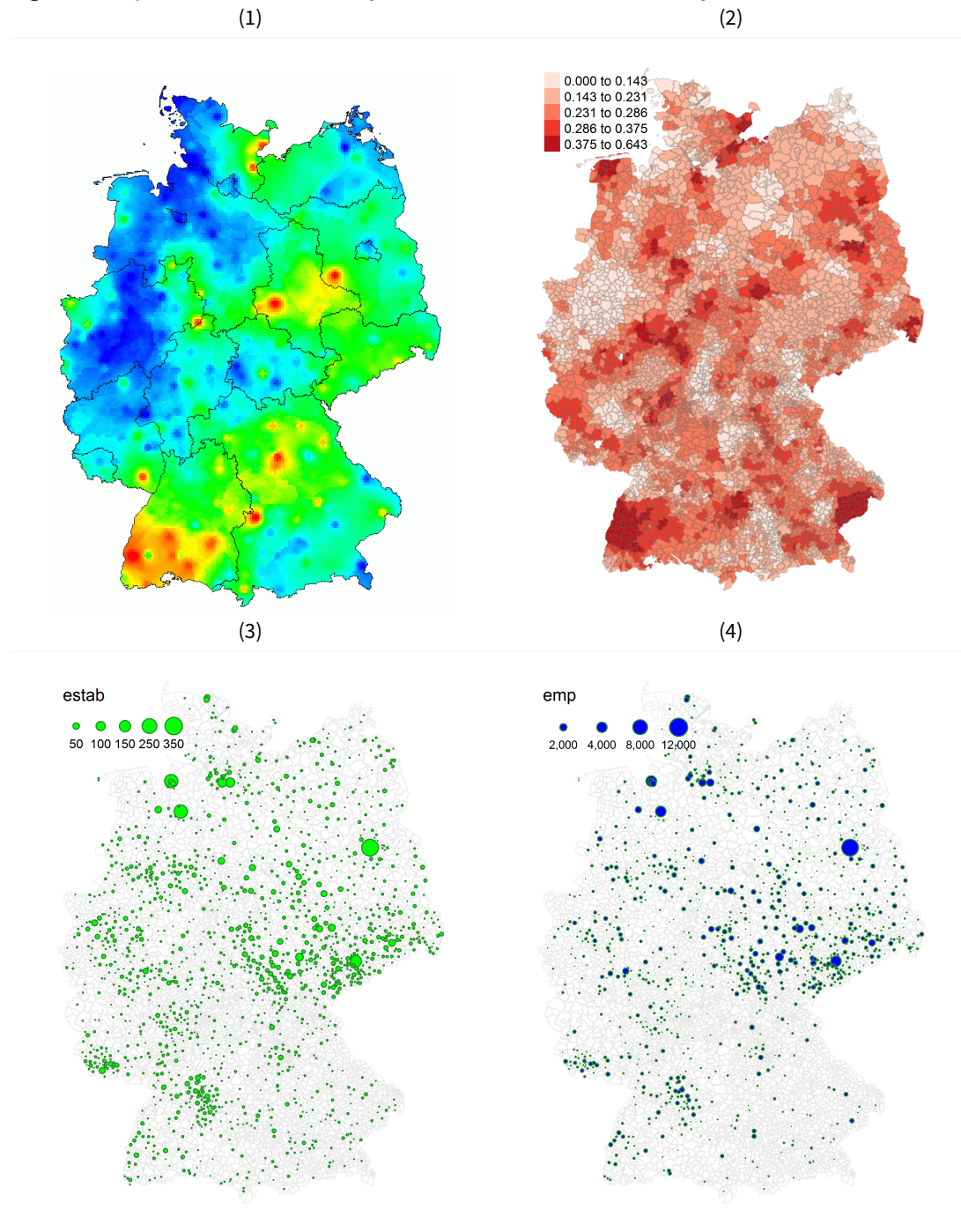
**Table 2: Summary statistics**

	Variable	Mean	Std.dev.	Min.	Median	Max.
TFP	TFP (baseline)	-0.011	0.696	-6.723	-0.006	3.993
	TFP (fixed-effects)	0.009	0.821	-5.260	0.046	4.139
Municipality	Commuter balance	1.145	0.556	0.302	0.968	4.920
	level Unemp. rate	0.089	0.042	0.010	0.084	0.228
	Share service sector	0.624	0.153	0.079	0.647	0.939
	Log(pop. density)	5.445	1.208	2.416	5.349	7.992
	Regional. share old	0.202	0.029	0.085	0.201	0.331
Firm level	Median wage	79.490	27.136	0	77.685	285.180
	Share old. emp.	0.275	0.122	0	0.265	1
	Share trainee	0.050	0.056	0	0.038	0.600
	Share mini.	0.064	0.109	0	0.020	0.960
	Share female	0.270	0.200	0	0.205	1
	Share high skilled	0.105	0.112	0	0.074	1
	Dum(1= overtime)	0.859	0.348	0	1	1
	Dum(1 = firm health)	0.659	0.474	0	1	1

Source: Own calculations.

the reporting medical offices (see Figure A1) are spatially smoothed using spatial statistics (Ordinary Kriging) and additional regional variables, which provide us with substantial regional variation. Our main indicator of local URTI intensity that was derived from the basis map is depicted in map (2). It visualizes only the geographical variation across municipalities with respect to the share of weeks per influenza season (calendar year, Jan – Dec.) with relative high URTI intensity. The map of 2009 exhibits significant regional variation in the local exposure to URTI. The influenza season of 2009 stands out as an unusually intense and long influenza season (see Table 1). However, we can see that the local hotspots of URTI are neither clustered in specific regions of Germany nor bounded to cities or their surroundings. As can be discerned from panel (3) and (4), the firms and the respective number of employees from our survey are distributed equally across Germany. Overall, with our analysis sample, we achieve a comprehensive and (geographically) representative coverage of the spatial distribution of economic activity in Germany.

Figure 1: Maps of influenza intensity and establishments in Germany



Notes: The map shows the median commuting distance to the new job of all job seekers by municipality of residence in manually chosen distance categories. Municipalities with 'no obs.' emerge due to missing job matches in that region. Panel (1) shows the flu intensity (»ARE Praxisindex«) in week 8, 2009. In panel (2) we visualize the relative season intensity by municipality (1 = 26 weeks of highest flu intensity according to the »ARE Praxisindex«). The regional distribution of establishments (panel (3)) as well as the employed in the establishments (panel (4)) of the IAB Establishment Panel Survey (analysis sample).  
Source: Own calculations



## 5 Regression Results

To address the effects of the URTI intensity on local firm productivity we rely on a panel of municipalities<sup>1</sup> covering the years 2003 until 2009. First, we present a baseline model documented in Table 3. Both indicators of URTI show the expected negative relationship with TFP, i.e. if a municipality experienced a longer flu season, firms in these municipalities appear to have a lower productivity in this year. However, firm productivity also appears as strongly affected by the regional economic activity as well by other firm observables. We want to use the full annual variation in the intensity of the influenza, thus we cannot use regional fixed effects to control for unobservable regional characteristics. In columns (3) and (4), we integrate a more comprehensive set of regional controls, which in turn, reduce the magnitude of the effect of the influenza on TFP. Next, we plug in firm control variables. What stands out from these results are the two additional firm variables merged from the IAB-EP survey, namely the indicator for the use of overtime and health measures in a firm. Short-term flexibility in the use of labor in response to URTI appears to increase the firm's productivity (*ceteris paribus*). Furthermore, a firm can implement active health management measures. Such measures have direct costs, however, they might rather be visible in the well-being of the employees than in the productivity directly. Overall, after controlling for (observable) regional and firm variables, we still find, although weakly significant, a negative effect of local URTI intensity on the total factor productivity of the firm.

In the next step, we parse the estimation of the total factor productivity by adding several controls. In column (2) of table 4 we estimated the TFP separately by industry, which only changes the results marginally. Next, we include year dummies in the TFP regression to account for the temporal variation in a firm's productivity. In (4) we use both. Overall, we find only little variation in the main point estimate, as well as in the significance levels when using alternative TFP estimations. Yet, the effects of the URTI intensity on productivity remains negative and significant. The coefficient as well as the precision of our point estimates increases after controlling for unobserved heterogeneity of the firm in the productivity estimation. The fit of our model also increases substantially by a factor of four.

In Table 5, we use the total number of flu intensity. Hence, the coefficient may be interpreted as a semi-elasticity, i.e. an additional week of outstanding local flu intensity decreases the TFP of a firm on average by 1.3 percent (see column 6). As the absolute value is the base for the relative intensity, the significance and model fit follow the results of Table 3.

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<sup>1</sup> Technically, we are looking at association of municipalities, often smaller towns and villages, cooperate with its neighbors, e.g., to save administration costs, however, still are independent.

**Table 3: Baseline - Firm productivity effects of Influenza-like illnesses**

	Dependent Variable: Total Factor Productivity (TFP)					
	(1)	(2)	(3)	(4)	(5)	(6)
Rel. flu intensity	-0.600*** (0.158)		-0.361*** (0.138)		-0.256+ (0.166)	
Abs. flu intensity		-0.022*** (0.006)		-0.013** (0.005)		-0.009+ (0.006)
Commuter balance			-0.075*** (0.028)	-0.075*** (0.028)	-0.018 (0.030)	-0.018 (0.030)
Unemp. Rate			-1.191*** (0.403)	-1.192*** (0.403)	-0.111 (0.482)	-0.111 (0.482)
Share office worker			0.093 (0.098)	0.094 (0.098)	0.288*** (0.107)	0.288*** (0.107)
Log(pop. density)			0.043*** (0.014)	0.043*** (0.014)	-0.015 (0.016)	-0.015 (0.016)
Share old emp.			-0.437 (0.566)	-0.440 (0.567)	0.375 (0.598)	0.373 (0.598)
Firm median wage					0.006*** (0.001)	0.006*** (0.001)
Firm share old					0.121 (0.122)	0.121 (0.122)
Share apprentice					-1.384*** (0.260)	-1.384*** (0.260)
Firm share mini job					-0.715*** (0.124)	-0.715*** (0.124)
Firm share female					-0.369*** (0.079)	-0.369*** (0.079)
Firm share high skilled					0.081 (0.161)	0.081 (0.161)
Dum (1 = add. hours)					-0.063* (0.035)	-0.063* (0.035)
Dum (1 = firm health)					-0.148*** (0.026)	-0.148*** (0.026)
R <sup>2</sup>	0.009	0.009	0.028	0.028	0.131	0.131
N	10,479	10,479	10,469	10,469	7,520	7,520

Notes: All results are purged for year effects. The estimated TFP is controlled for establishment year effects; Standard errors clustered at municipality level in parentheses; Levels of significance: + p < 0.15, \* p < 0.1, \*\* p < 0.05, \*\*\* p < 0.01  
Source: Own calculations.

**Table 4: Firm productivity effects of influenza-like illnesses (relative intensity)**

	Dependent Variable: Total Factor Productivity (TFP)					
	(1)	(2)	(3)	(4)	(5)	(6)
Rel. flu intensity	-0.256+ (0.166)	-0.284+ (0.182)	-0.256+ (0.166)	-0.284+ (0.182)	-0.341** (0.164)	-0.341* (0.178)
TFP est. by industry	N	Y	N	Y	N	N
year effects	N	N	Y	Y	N	Y
estab. fixed effects	N	N	N	N	Y	Y
R <sup>2</sup>	0.131	0.064	0.126	0.066	0.356	0.474
N	7,520	7,520	7,520	7,520	7,520	7,520

Notes: All results are purged for year effects. Standard errors clustered at municipality level in parentheses; Levels of significance: + p < 0.15, \* p < 0.1, \*\* p < 0.05, \*\*\* p < 0.01  
Source: Own calculations.

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**Table 5: Firm productivity effects of influenza-like illnesses (absolute intensity)**

Dependent Variable: Total Factor Productivity (TFP)

	(1)	(2)	(3)	(4)	(5)	(6)
Rel. flu intensity	-0.009+ (0.006)	-0.010+ (0.007)	-0.009+ (0.006)	-0.010+ (0.007)	-0.013** (0.006)	-0.013* (0.007)
TFP est. by industry	N	Y	N	Y	N	N
year effects	N	N	Y	Y	N	Y
estab. fixed effects	N	N	N	N	Y	Y
R <sup>2</sup>	0.131	0.064	0.126	0.066	0.356	0.474
N	7,520	7,520	7,520	7,520	7,520	7,520

Notes: All results are purged for year effects. Standard errors clustered at municipality level in parentheses;  
Levels of significance: + p < 0.15, \* p < 0.1, \*\* p < 0.05, \*\*\* p < 0.01

Source: Own calculations.

## 6 Conclusion

This research is the first to combine data on the epidemiology of the influenza and, more generally, acute infectious diseases of the upper respiratory tract with a comprehensive firm level survey to assess the effect of the influenza-like diseases on firm productivity in Germany. In firm level data that are available for economic research, there is a lack of precise information on worker absences due to sickness. We tackle this issue by using epidemiological data from the official influenza surveillance system AGI in Germany set up by the RKI, which are highly correlated with worker absences. Moreover, data on URTI are plausibly related to the phenomenon of presenteeism, which describes productivity impairments of sick workers who remain at work. Combining URTI data by location with firm level data, we approximate the exposure of firms to unforeseeable exogenous health shocks on their workforce. This argumentation relies on the rationale that firms predominantly draw on local workforce, i.e. their production function via the shock on the factor labor is affected from illness caused by outstanding local influenza outbreaks. To the best of our knowledge, we are the first to exploit data from the official influenza surveillance system AGI in labor market research. Our main results highlight the proposed nexus between the local flu intensity by year and firm productivity. Precisely, we find that the local URTI intensity does affect firm's productivity negatively. A marginal increase of the influenza season by one week in a municipality reduces TPF of the localized establishments on average by about 1.3 percent. Based on the epidemiology of URTI, we argue that the estimated effect in our main model represents a sizable causal effect of the local flu intensity on productivity. We attribute this effect to both absences from work from due to sickness as well as to productivity impairments of workers who are affected by URTI but remain at work (presenteeism). While we are able to estimate the joint effect of both mechanisms on firm productivity, our approach does not allow for disentangling the two effects. By its very nature, the effects estimated using the information collected in the influenza surveillance system, provide only lower bounds of the true effect. This is because URTI data are only based on doctoral consultations instead of actual absences. Health data show that individuals who suffer from URTI and see a doctor stay away from work for about seven days. Our indicator, however, does not cover shorter absences of up to two working days without doctoral consultations.

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