Spatial internet spillovers in manufacturing

Supplementary materials

Content

A. Instrumental Variable setting.

A.1. Instrumental variables' rationale

The number of SMCs.

The exponential rise in their deployment over time has led to a dramatic increase in the worldwide telecommunications network's size, capacity, and redundancy. While SMCs' roll-out leads to an increased internet capacity and digitalisation (Cariolle, 2021), it also generates a higher exposure to outage risks, which can be mitigated only if there is enough alternative SMC paths to reroute internet traffic.

One attribute of SMCs, relevant to our empirical strategy, is that their laying faces strong geographical and geological constraints (Cariolle, 2021; Carter, 2010; Eichengreen, Lafarguette & Mehl, 2016; World Bank 2018; Simione & Li, 2021), and therefore very high fixed costs. As a result, SMCs are usually managed by large consortia of public and private operators and investors, deployed at the regional or intercontinental levels, and laid in various countries located along their path, to take advantage of scale economies. Nevertheless, (non-) treatment could be subject to a selection bias, i.e. more likely in more (less) economically dynamic countries. That is why our causality claim is subject to fully controlling for cross-country-year characteristics, which is done through the inclusion of country-year fixed-effects.

SMCs' outages.

The SMCs' infrastructure integrity is critical for international exchanges and threats upon it are a key concern for governments, companies, and international agencies.[9] SMCs' outages, caused by humans (sabotage, maintenance), maritime activities (anchors and fishing nets) or natural hazards (typhoons, earthquakes, turbidity currents), are a critical source of telecommunication shut- or slowdowns (Carter et al., 2010; Carter, 2014; see also Aceto, Botta, Marchetta, Persico, & Pescapé, 2018; Pope, Talling, & Carter, 2017). Moreover, in addition to the direct economic and welfare costs related to telecommunication disruptions, SMCs' outages induce expensive repairs, higher insurance costs, and additional costs related to the re-routing of internet traffic towards more expensive and lower-capacity cable paths. Importantly, these direct and indirect costs are amplified by the time needed to repair cables (Carter et al., 2010; OECD, 2014; Palmer-Felgate, Irvine, Ratcliffe, & Bah, 2013). While SMCs' outages increase the network's vulnerability and undermines internet stability, the number of SMCs can limit outages' consequences by providing alternative networks in the event of failure of one or various SMCs.

Our IV therefore also exploits country-level variations in cumulative annual time to repair cables, reflecting both the recurrence and duration of adverse shocks incurred by the SMCs' network. This has been done by building an original database documenting the occurrence of SMC-induced internet disruptions by country and year, the cause of these outages, as well as the duration (in days) of cable repairs, over the 2005-2020 period. It is worth noting that only cable faults that have caused internet disruptions are considered. Due to possible endogeneity concerns, we drop all observations from the sample that include a cable outage induced by natural hazards (earthquake, hurricanes, and floods). In fact, natural shocks could directly affect firms' performance, regardless of their use of internet, by causing material and human casualties. For similar concern, we also drop observations for which internet disruptions are suspected to have been caused by a government

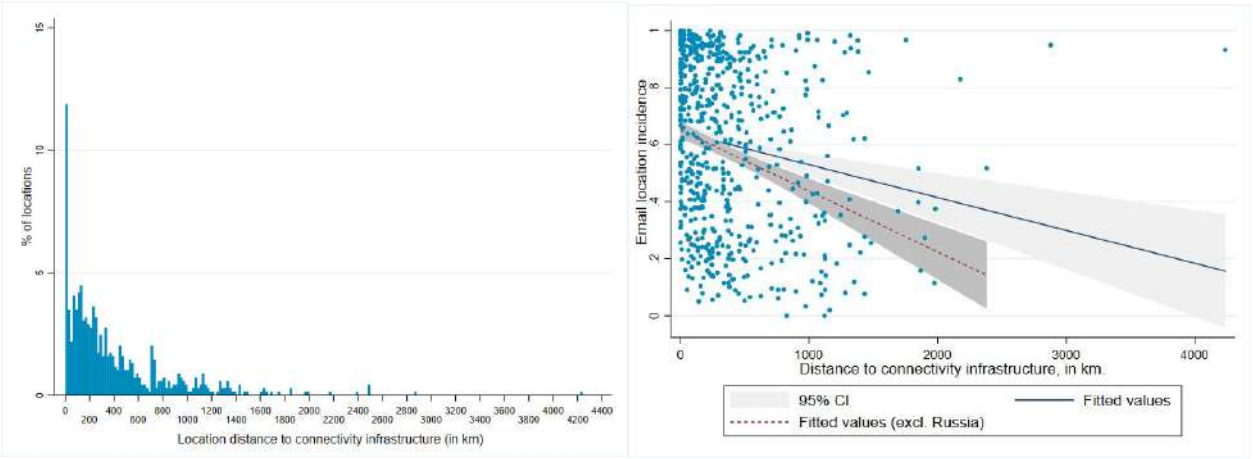
intervention.[12] In our estimation sample, 30 out of 91 countries have experienced internet disruptions caused by SMCs' faults – induced by ship anchoring, fishing nets, sabotage, or unidentified causes – during the current and four years preceding the reference fiscal year (Table 2).

Weighting factor: distance to connectivity infrastructure.

Our IV design assumes that firms' exposure to SMCs' connectivity shocks depends on their distance to the closest international connectivity infrastructure. In a core-periphery setting, populations remote from (close to) connectivity infrastructures are more (less) exposed to telecommunication network disruptions and suffer (benefit) from worse (better) connectivity than close (remote) ones. This spatial hierarchy in internet connectivity is explained by the necessity to maintain internet access in most important economic and population centres if the whole network capacity is undermined. As a result, urban and coastal areas are favoured, compared to rural and inland ones, when national capacity increases but also when disruptions occur (Grubesic & Murray, 2006; Grubesic, O'Kelly, & Murray, 2003; Gorman & Malecki, 2000; Gorman, Schintler, Kulkarni, & Stough, 2004; Malecki, 2002).

Using information on the location of observational units (city or region identification) available in the WBES, we use the distance between the firm's location centroid and the closest SMC landing station or IXPs as a weight placed upon aggregate shocks. A distance raster map is defined from all coordinate points, which gives the distance of each firm's location centroid to the nearest connectivity infrastructure. When the geographical stratification unit is the region or a group of cities, which sometimes happens in the data-set, we take the region's or city group's centroid as geographical coordinate. If a country does not host any SMC or IXP, the distance is calculated with respect to the closest infrastructure in neighbouring countries. SMC landing stations and IXPs indeed represent key backbone infrastructure nodes and an important source of network efficiency and internet bandwidth (OECD, 2014; Weller & Woodcock, 2013).[13] This distance variable is included alone in the econometric equation to control for the direct effect of infrastructure proximity on local internet diffusion and firm performance. Figure I shows the distribution of this distance variable across locations in our baseline estimation sample. Figure I also plots a negative correlation between the sample locations' distance to connectivity infrastructures and the incidence of email use at the location level. Last figure II shows that the exposure to SMC outages increase with the number of SMCs.

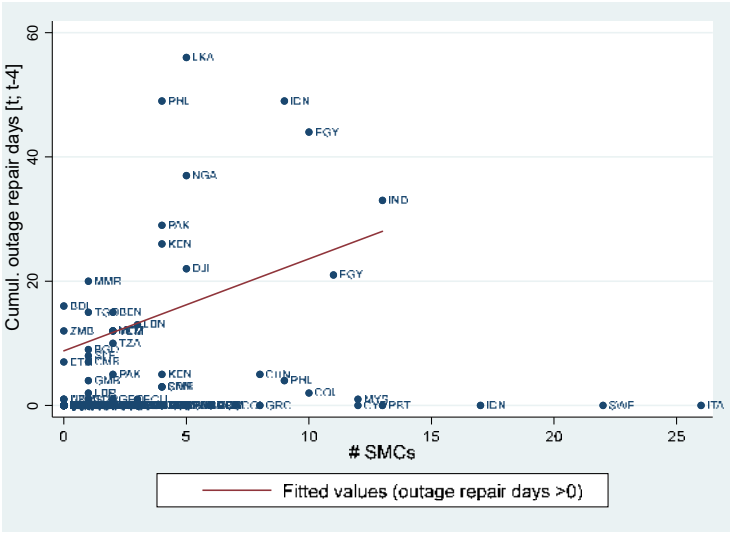
Figure I. Location distances to international connectivity infrastructures (SMCs or IXPs): sample distribution and correlation with email incidence.



(a) Sample distribution.

(b) Correlation with location email incidence.

Figure II. SMC number and exposure to outages



A.2. Instrument set calibrations (with first stage estimates).

Estimations resulting from various IV calibrations are reported below. First-stage estimates confirm the nested nature of IV1 and IV2. First, using both instruments together increase the LM statistic and therefore reduces the risk of under-identification. Second, while first-stage estimations stress that the outage-based instrument (IV2) used as single instrument positively affects email location incidence, this effect has the expected negative sign after including the SMC-based instrument (IV1), or, after excluding from the sample Eastern and South-Eastern Asian countries which present the characteristics of having a large number of cables and being frequently exposed to SMCs' outages. This indicates that a greater experience of SMCs' outages also results from a higher number of SMCs (as also shown by the correlation matrix in Appendix E and the correlation graph presented Figure II above). In the last three columns, we estimate a reduced form equation where the sale variable is directly regressed over IV1 and IV2, together and separately. Results stress that these reduced estimates are similar in significance and sign as first-stage estimates reported in columns (1), (5), and (6).

Dep. Var: Total sales (ln, USD)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	First stage estimates							**Reduced form estimations**			
	Baseline sample					Excl. East-Asia & Pac	Unrestricted IVs	Baseline sample		Excl. East-Asia & Pac	Baseline sample
IV1	0.036***	0.170***	0.171***	0.175***			0.179***	0.515***			0.121
	(0.002)	(0.057)	(0.057)	(0.058)			(0.062)	(0.035)			(0.192)
IV2 -- calibrations											
(τ1 = 0; τ2 = 2)		-0.007**									
		(0.003)									
(τ1 = 0; τ2 = 3)			-0.010**								
			(0.004)								
(τ1 = 0; τ2 = 4)				-0.012**	0.002***	-0.064**	-0.013**		0.045***	-0.496***	0.035**
				(0.005)	(0.000)	(0.028)	(0.005)		(0.004)	(0.167)	(0.018)
Control variables:											
Email adoption	-0.005***	-0.006***	-0.006***	-0.006***	-0.005**	-0.003***	-0.005**	-	-	-	-
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	-	-	-	-
Website adoption	0.001*	0.001**	0.001**	0.001**	0.001	0.000	0.001**	-	-	-	-
	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)	-	-	-	-
Exports	0.000	0.000	0.000	0.000	0.000	-0.000**	0.000	-	-	-	-
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	-	-	-	-
Initial # perm. FT employees	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-	-	-	-
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	-	-	-	-
% non-production workers	-0.002	-0.002	-0.002	-0.002	-0.002	-0.000	-0.002	-	-	-	-
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.000)	(0.001)	-	-	-	-
% skilled workers	0.002	0.001	0.001	0.001	0.002	-0.000	0.001	-	-	-	-
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	-	-	-	-

Manager exp	-0.000	-0.000	-0.000	-0.000	-0.000	0.000**	-0.000	-	-	-	-
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	-	-	-	-
Firm's age	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000***	-0.000***	-	-	-	-
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	-	-	-	-
% of foreign ownership	0.002*	0.002*	0.002*	0.002*	0.002*	0.001**	0.002*	-	-	-	-
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	-	-	-	-
% of state ownership	0.001	0.001	0.001	0.001	0.001	-0.000**	0.001	-	-	-	-
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	-	-	-	-
Bank loan (0 or 1)	0.010***	0.044***	0.045***	0.046***	0.001	0.002	0.047***	-	-	-	-
	(0.002)	(0.015)	(0.015)	(0.015)	(0.002)	(0.002)	(0.016)	-	-	-	-
Electricity obstacle	-0.005***	-0.006***	-0.006***	-0.006***	-0.005**	-0.003***	-0.005**	-	-	-	-
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	-	-	-	-
Distance to connectivity infra	0.001*	0.001**	0.001**	0.001**	0.001	0.000	0.001**	-	-	-	-
	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)	-	-	-	-
	Second-stage estimates										
Internet	14.470***	4.585***	4.523***	4.341***	24.198***	8.008***	3.715***	-	-	-	-
	(1.367)	(0.746)	(0.741)	(0.726)	(1.599)	(1.671)	(0.737)	-	-	-	-
Email adoption	0.736***	0.690***	0.689***	0.689***	0.781***	0.766***	0.694***	0.658***	0.659***	0.743***	0.659***
	(0.093)	(0.111)	(0.111)	(0.112)	(0.077)	(0.084)	(0.129)	(0.117)	(0.117)	(0.083)	(0.117)
Website adoption	0.619***	0.627***	0.627***	0.627***	0.612***	0.640***	0.676***	0.632***	0.632***	0.644***	0.632***
	(0.053)	(0.051)	(0.051)	(0.051)	(0.056)	(0.057)	(0.050)	(0.050)	(0.050)	(0.059)	(0.050)
Exports (% sales)	0.006***	0.006***	0.006***	0.006***	0.006***	0.008***	0.006***	0.006***	0.006***	0.008***	0.006***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Initial # perm. FT employees	0.643***	0.641***	0.641***	0.641***	0.644***	0.544***	0.628***	0.640***	0.640***	0.554***	0.640***
	(0.040)	(0.040)	(0.040)	(0.040)	(0.039)	(0.044)	(0.036)	(0.040)	(0.040)	(0.042)	(0.040)
Manager exp	0.027	0.002	0.002	0.002	0.051	-0.010	0.006	0.003	0.003	-0.001	0.003
	(0.063)	(0.061)	(0.061)	(0.061)	(0.069)	(0.052)	(0.061)	(0.062)	(0.062)	(0.046)	(0.062)
Firm's age	0.179***	0.199***	0.199***	0.200***	0.159***	0.280***	0.169***	0.203***	0.204***	0.222***	0.203***
	(0.051)	(0.048)	(0.048)	(0.048)	(0.057)	(0.050)	(0.055)	(0.047)	(0.047)	(0.054)	(0.047)
% of foreign ownership	0.009***	0.008***	0.008***	0.008***	0.009***	0.010***	0.009***	0.009***	0.009***	0.009***	0.009***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
% of state ownership	0.004***	0.004***	0.004***	0.004***	0.004***	-0.000	0.003***	0.004***	0.004***	-0.000	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.004)	(0.000)	(0.001)	(0.001)	(0.004)	(0.001)
Bank loan	0.559***	0.577***	0.577***	0.577***	0.542***	0.613***	0.600***	0.586***	0.587***	0.615***	0.587***
	(0.055)	(0.050)	(0.050)	(0.049)	(0.060)	(0.066)	(0.048)	(0.048)	(0.048)	(0.066)	(0.048)
Electricity obstacle	0.016	0.023	0.023	0.023	0.010	-0.000	0.006	0.029	0.029	-0.015	0.029
	(0.032)	(0.031)	(0.031)	(0.031)	(0.035)	(0.021)	(0.031)	(0.030)	(0.030)	(0.019)	(0.030)
Distance to connectivity infra	-0.031	-0.019	-0.019	-0.019	-0.042	-0.034	-0.017	0.114***	-0.018	-0.020	0.013
	(0.050)	(0.041)	(0.041)	(0.041)	(0.065)	(0.045)	(0.046)	(0.038)	(0.039)	(0.041)	(0.063)
Control variables (X_{it}) & FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
KP Wald F stat	304.7	97.06	98.84	107.2	107.6	5.248	107.5	-	-	-	-

LM stat	1.993	7.646***	7.688***	7.868***	1.648	1.575	8.298***	-	-	-	-
Hansen J (P-val.)	-	0.200	0.200	0.201	-	-	0.205	-	-	-	-
N	44,073	44,073	44,073	44,073	44,073	37,493	46,443	44,095	44,095	39,916	44,095
R-squared	0.312	0.342	0.342	0.342	0.249	0.319	0.346	0.346	0.347	0.329	0.347

Note: * significant at 10%, ** significant at 5%, *** significant at 1%. Control estimates of 1st-stage equation not reported. Standard errors are presented in parentheses, and are robust to heteroscedasticity and clustered by country-year of survey. In column (7), we consider internet outages induced by natural hazards and government interventions in IV2 computation.

A.3. IV1 decomposition and identification restrictions.

Following Borusyak et al.(2021), we report IV estimates when IVs' components – i.e. aggregate connectivity shocks or distance to infrastructures – are separately fixed, that is, set to their value at the fiscal year of the first survey round. The resulting estimates and associated first-stage statistics support that our results stem from variations in the aggregate component (i.e. SMC number and outage days) rather than variations in the weight component (i.e. distance to infrastructure) of IVs.

Dep var: total sales.	(1)	(2)	(3)	(4)	(5)	(6)
IV's fixed component:	**Ln distance infrastructure**			**Connectivity shocks**		
$\overline{Internet}$	14.039***	21.728***	3.479***	7.938	-7.004***	2.936
	(0.866)	(1.358)	(0.487)	(6.215)	(0.814)	(4.014)
	1st stage estimates					
IV1	0.019***		0.127***	0.053*		0.055*
	(0.001)		(0.032)	(0.028)		(0.028)
IV2†		0.000***	-0.003***		-0.001***	-0.002***
		(0.000)	(0.001)		(0.000)	(0.000)
X_{it} & FEs (d_{jt}, d_l, d_k)	Yes	Yes	Yes	Yes	Yes	Yes
KP Wald F stat	581	151.9	963.6	3.468	118.7	58.50
Hansen J test (P-val.)	-	-	0.208	-	-	0.113
N	44073	44073	44073	44073	44073	44073

Note: * significant at 10%, ** significant at 5%, *** significant at 1%. Control estimates not reported. Standard errors, presented in parentheses, are robust to heteroscedasticity and clustered by country-year of survey. In columns (1)-(2), the IV weighting factor (distance to infrastructure) is set to its value at the first survey wave, while in columns (3)-(4), the number of SMCs is set to its value at the first survey wave. Control estimates can be provided upon request, or refer to data and codes.

† In order to be able to fix IV2's components, we had to make IV2's calculation differing slightly from equation (4), since here, we weight the sum of outage days over (t; t-4) with the location distance to infrastructure (km, ln) measured at the year of survey. As reminder, IV2 is the 5-year average of the product between lagged values of outages days and location distance to infrastructure.

B. Robustness checks

B.1. Controlling for unobserved local economic performance, pre-trend, and non-random exposure to shocks.

Controlling for unobserved local economic performance (col. (1) and (2))

The proxy of local economic activity is the residual of an OLS (or IV 2SLS) regression of the average location sales over firm's sales, location email diffusion, as well as location, country-year and sector fixed-effects:

$$\bar{Y}_{l(i)t(i)} = \alpha + \beta.\overline{Internet}_{l(i)t(i)} + \gamma.Y_i + d_{j(i)t(i)} + d_{l(i)} + d_{s(i)} + \varepsilon_{Yi}^{OLS-IV} \quad (9)$$

Where $\bar{Y}_{l(i)t(i)}$ is the average annual sales of other firms located in location *l*, that is, excluding firm i's own sales, and $\varepsilon_{Yi}^{OLS-IV}$ the residual from an OLS or IV-2SLS estimation of Equation (9). Equations (1a) and (1b) are then re-estimated using the 2SLS-FE estimator and including the residual $\varepsilon_{Yi}^{OLS-IV}$ as an additional control variable.

Non-random exposure to shocks (col. (5) to (7))

"Expected IV1 and IV2" are constructed by respectively drawing 2000 counter-factual connectivity shocks – i.e. shocks on SMCs' number or outage days – from a Normal, Poisson and Uniform distributions with mean and standard deviation equal to the corresponding moments of these variables' historic distribution, and then weighting these "expected values" by the location distance to infrastructures.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dep var: total sales	**Local econ. activity**		**Pre-trend**		**Non-random exposure**		
	OLS-based	IV-based		Red.form	Normal	Poisson	Uniform
Internet spillovers	4.069***	3.834***	-0.288	-	3.838***	4.341***	4.419***
	(0.933)	(0.727)	(1.735)	-	(1.040)	(0.726)	(0.644)
$Epsilon_{Yi}$	-0.004	0.010	-	-	-	-	-
	(0.018)	(0.021)	-	-	-	-	-
	First stage estimations						
IV1	0.172**	0.180***	0.182***	-0.530	-	-	-
	(0.073)	(0.064)	(0.058)	(0.673)	-	-	-
IV2	-0.012*	-0.013**	-0.013**	0.070	-	-	-
	(0.007)	(0.006)	(0.005)	(0.058)	-	-	-
Recentered IV1	-	-	-	-	0.150***	0.175***	0.177***
	-	-	-	-	(0.053)	(0.058)	(0.058)
Recentered IV2	-	-	-	-	-0.010**	-0.012**	-0.013**
	-	-	-	-	(0.005)	(0.005)	(0.005)
X_{it} + FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$Epsilon\_OLS_{Yi}$	Yes	No	-	-	-	-	-
$Epsilon\_IV_{Yi}$	No	Yes	-	-	-	-	-
KP Wald F-stat	98.97	59.89	109.15	-	149.3	107.2	115.2
LM Weak	3.449	5.483	7.504	-	9.388	7.868	8.107
Hansen Jtest (P-val.)	0.196	0.217	0.260	-	0.192	0.201	0.200
N	44,073	44,073	42,022	42,022	44,073	44,073	44,073

Note: * significant at 10%, ** significant at 5%, *** significant at 1%. Control estimates not reported. Standard errors, presented in parentheses, are robust to heteroscedasticity and clustered by country-year of survey. In columns (3) and (4) the dependent variable is the 3-year lagged total sales. In column (4), a reduced form of our model is estimated, consisting in estimating the direct effect of IV1 and IV2 on the 3-year lagged total sales. In column (5), we generate counterfactual SMC-number (IV1) and outage-days (IV2) shocks from a Normal, Poisson and Uniform distributions based on the corresponding moments of connectivity shock variables' historic distributions.

B.2. Controlling for unobserved inter-industry linkages and output characteristics.

Dep var: total sales (Ln, USD)	(1)	(2)	(3)	(4)
	Inter-industry FE		ISIC product FE	
(A) $\overline{Internet}$	4.341***		4.462***	
	(0.726)		(0.734)	
(B) $\overline{Internet\_inter}$		-13.852***		-13.900***
		(2.372)		(1.860)
(C) $\overline{Internet\_intra}$		22.353***		22.168***
		(2.221)		(2.300)
	1st-stage statistics			
Weak-id SW F-stat :				
(A)	107.22		122.09	
(B)		28.01		28.15
(C)		77.15		69.51
Under-id Chi-2 stat:				
(A)	218.93		250.51	
(B)		28.60***		28.89
(C)		78.78***		71.33
Controls	Yes	Yes	Yes	Yes
Country-year FE	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	No	No
Location FE	Yes	Yes	Yes	Yes
Industry-pair FE	**Yes**	**Yes**	**No**	**No**
4-digit ISIC product FE	**No**	**No**	**Yes**	**Yes**
Hansen J-test (p-value)	0.201	-	0.156	-
N	44073	43490	43407	42853

Note: * significant at 10%, ** significant at 5%, *** significant at 1%. Control estimates not reported. Standard errors, presented in parentheses, are robust to heteroscedasticity and clustered by country-year of survey.

B.3. Excluding landlocked countries.

	(1)	(2)	(3)	(4)
Dep var (Ln, USD):	**Total sales**		**Tot. sales per worker**	
(A) $\overline{Internet}$	3.795***		4.168***	
	(0.751)		(0.522)	
(B) $\overline{Internet\_inter}$		-12.825***		-11.121***
		(2.008)		(1.472)
(C) $\overline{Internet\_intra}$		21.695***		19.812***
		(2.150)		(1.374)
	1st-stage statistics			
Weak-id SW F-stat :				
(A)	96.48		96.35	
(B)		23.87		22.20
(C)		71.45		66.90
Under-id Chi-2 stat:				
(A)	197.21		196.96	
(B)		24.40		22.70
(C)		73.04		68.39
X_{it} + FEs (d_{jt}, d_l, d_k)	Yes	Yes	Yes	Yes
Hansen test p-val.	0.19	-	0.22	-
N	37730	37674	37341	37285

Note: * significant at 10%, ** significant at 5%, *** significant at 1%. Control estimates not reported. Standard errors, presented in parentheses, are robust to heteroscedasticity and clustered by country-year of survey.

B.4. Internet spillovers for inward-oriented SMEs.

	(1)	(2)	(3)	(4)
Dep. Var:	**Total sales**		**Tot. sales per worker**	
(A) $\overline{Internet}$	1.332**		1.561***	
	(0.614)		(0.601)	
(B) $\overline{Internet\_inter}$		-6.543***		-5.386***
		(1.384)		(1.234)
(C) $\overline{Internet\_intra}$		9.769***		8.391***
		(0.825)		(0.837)
	1st-stage statistics			
Weak-id SW F-stat :				
(A)	98.98		99.03	
(B)		50.51		50.18
(C)		125.37		124.46
Under-id Chi-2 stat:				
(A)	204.73		204.84	
(B)		52.24		51.91
(C)		129.68		128.74
X_{it} + FEs (d_{jt}, d_l, d_k)	Yes	Yes	Yes	Yes
Hansen test p-val.	0.230	-	0.249	-
N	23,730	23,695	23,404	23,369

Note: * significant at 10%, ** significant at 5%, *** significant at 1%. Control estimates not reported. Standard errors, presented in parentheses, are robust to heteroscedasticity and clustered by country-year of survey.

Appendix B.5. Internet spillovers in locations with N ≥ 50 observations.

Dep var (Ln, USD):	(1)	(2)	(3)	(4)
	Total sales		Tot. sales per worker	
(A) $\overline{Internet}$	4.246***		4.302***	
	(0.540)		(0.593)	
(B) $\overline{Internet\_inter}$		-14.066***		-13.815***
		(2.606)		(2.434)
(C) $\overline{Internet\_intra}$		21.010***		20.560***
		(1.739)		(1.542)
	1st-stage statistics			
Weak-id SW F-stat :				
(A)	99.07		99.05	
(B)		30.84		28.70
(C)		79.25		74.91
Under-id Chi-2 stat:				
(A)	201.89		201.85	
(B)		31.42		29.25
(C)		80.76		76.33
X_{it} + FEs (d_{jt}, d_l, d_k)	Yes	Yes	Yes	Yes
Hansen test p-val.	0.20	-	0.21	-
N	42274	42213	41905	41844

Note: * significant at 10%, ** significant at 5%, *** significant at 1%. Control estimates not reported. Standard errors, presented in parentheses, are robust to heteroscedasticity and clustered by country-year of survey.

C. Additional estimations.

C.1. Intra and inter-industry internet spillovers, with alternative industry grouping.

Compared to Table 4 of the main document, i) firms operating in "manufactures of rubber and plastic products" and "manufactures-sales-maintenance of motor vehicles" sectors have been dropped from the "manufacture of vehicle, machinery and equipment" industry, and considered as separate industries; ii) firms (91) operating in "mining" and "manufacture of petroleum products" sectors have been dropped from the "Manufacture of extracted resource" industry. See subsection C.2.

Dep var (Ln, USD): total sales	(1)	(2)	(3)
	Second-stage estimates		
(A) $\overline{Internet\_inter}$	-11.396***	-21.090***	
	(1.731)	(3.183)	
(B) $\overline{Internet\_intra}$	16.231***		-162.452
	(1.369)		(339.030)
(C) $\overline{Internet\_inter}^2$		23.825***	
		(1.900)	
(C) $\overline{Internet\_intra}^2$			154.047
			(300.279)
Additional controls:			
$\overline{Internet\_intra}$		0.961***	
		(0.252)	
$\overline{Internet\_inter}$			-1.469
			(5.983)
	First-stage statistics		
Weak-id SW F-stat :			
(A)	18.13	49.06	

(B)	75.44		2.27
(C)		98.28	2.34
Under-id Chi-2 stat:			
(A)	18.51	50.10	
(B)	77.04		2.32
(C)		100.36	2.39
X_{it} + FEs (d_{jt}, d_l, d_k)	Yes	Yes	Yes
Lind & Melhum U-shape T-test (threshold)	-	6.62*** (0.44)	0.48 (0.53)
N	43301	43301	43301

Note: * significant at 10%, ** significant at 5%, *** significant at 1%. Control estimates not reported. Standard errors, presented in parentheses, are robust to heteroscedasticity and clustered by country-year of survey.

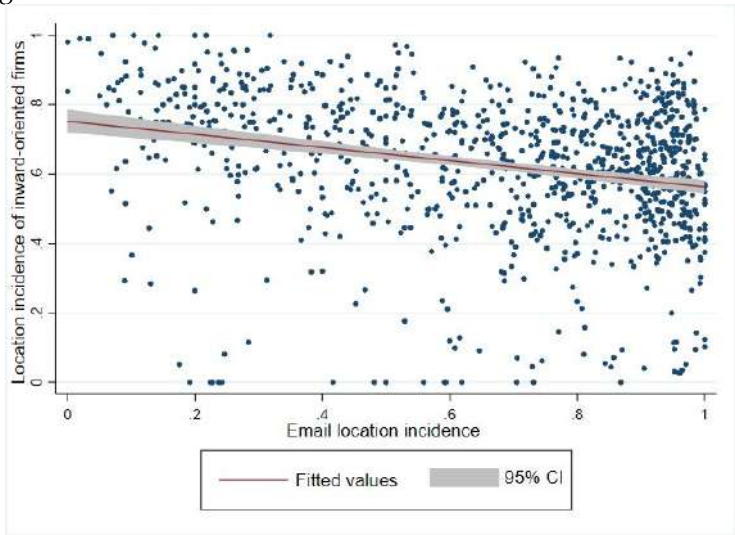
C.2. Correspondence between industries and sector stratification, baseline and alternative industry grouping.

Industry	**Sample**		**Sector strat.**	**Sample**	
	Total	**Baseline**		**Total**	**Baseline**
Construction	7,451 (16)	4	Construction	7,451 (16)	4
Manuf of machinery, equip., & motor vehicles	21,187	8,072	Manuf. of electrical machinery	2,333	1,413
			Manuf of electronic equipment	441	254
			Manuf of medical instruments	539	246
			Manuf of motor vehicles†	1,388	884
			Manuf of other transport equipment	357	141
			Manuf of paper prod.	1,129	560
			Manuf of machinery & equip.	4,886	2,457
			Manufacture of rubber & plastics prod.*	4,968	2,652
			Sale-maintenance-repair of motor vehicles†	5,146 (19)	1
Other Manufact.	1,679	824	Other Manuf.	1,100	512
			Recycling	257	116
			Manuf. of tobacco prod.	266	175
			Manuf. of office	56	21
Other services	4,451 (13)	1	Other services	4,370	0
			Real estate activities	57	0
			Recreational, cultural & sporting activities	12	0
			Electricity, gas, steam & hot water supply	12	1
Textiles Garments	17,718	9,135	Manuf. of textiles	5,898	2,913
			Manuf. of leather products	1,922	885
			Manuf. of wearing apparel	9,898	5,337
Metals and Machinery	9,303	4,819	Manuf of basic metals	2,095	1,240
			Manuf of fabricated metal prod.	7,208	3,579
Extractive industries	8,800	4,371	***Manuf of petroleum prod.‡***	202	110
			Manuf of wood prod.	2,669	1,337
			Mining ‡	8	3
			Manuf of other non-metallic mineral prod.	5,921	2,921
ICTs & media	6,681	1,643	Post & telecommunications	747	0
			Publishing & printing	3,092	1,643
			Computer & related activities	2,842	0
Transportation & storage	5,126 (7)	0	Supporting & auxiliary transport activities	2,281	0
			Transport communications	2,486	0
			Water transport	222	0
			Air transport	137	0
Wholesale	10,607 (20)	3	Wholesale trade commission trade	10,607	3
Retail	25,474 (76)	7	Retail trade	25,474	7
Food	17,970	8,737	Manufacture of food products	17,970	8,737
Furniture	4,480	2,290	Manufacture of furniture	4,480	2,290
Hospitality	7,646 (12)	4	Hotels restaurants	7,646	4
Chemicals.	6,366	3,620	Chemicals Chemical Prod.	6,366	3,411
Rest of the universe	112 (19)	7	Other business activities	51	3
			Agriculture	13	3
			Health & social work	48	0

Note: the sub-column "Total" reports the total number of both service and manufacturing firms, while the column "Estimation" reports the number of manufacturing firms in the estimation sample. The number of manufacturing firms in the total sample is sometimes specified in parenthesis to explain sample in attrition in the estimation sample.* The sector is considered as a separate industry in robustness analysis. Sectors are grouped together as a separate industry in robustness analysis. Sectors are dropped from "Manufacture of extracted resources" in robustness analysis.

C.3. Internet spillovers and outward orientation.

Figure: Firms' inward orientation and email incidence in locations.



Note: 972 pooled observations (725 locations, 136 countries).

Var. dep.: Total sales (Ln, USD)	(2)	(3)	(4)
	Second-stage estimates		
(A) $\overline{Internet\_inter}$	-5.728	-4.233*	4.807
	(5.720)	(2.425)	(3.522)
(B):			
$\overline{Internet\_inter}$ x dir. & indir. exports	1.412***		
	(0.332)		
$\overline{Internet\_inter}$ x foreign own.		0.762***	
		(0.110)	
$\overline{Internet\_inter}$ x multi-plant.			48.135***
			(6.116)
Interaction var.	-0.918***	-0.506***	-31.558***
	(0.233)	(0.067)	(3.651)
KP Wald F stat	3.945	4.869	5.359
X_{it} + FEs (d_{jt}, d_l, d_k)	Yes	Yes	Yes
N	43,490	43,490	43,490

Note: * significant at 10%, ** significant at 5%, *** significant at 1%. Control estimates not reported. Standard errors are presented in parentheses, and are robust to heteroscedasticity and clustered by country-year of survey.

C.4. Internet spillovers and workforce composition and innovation

Var. dep.(Ln, #):	(2) # FT perm. workers	(3) FT temp. workers	(4) FT perm. non prod. work.	(5) FT perm. prod. workers	(6) New products/service
			Second-stage estimates		
$\overline{Internet}$	-0.983**	-0.181	-1.115***	-1.451***	5.748***
	(0.424)	(0.486)	(0.316)	(0.401)	(2.037)
IV1	0.01902***	0.19105***	0.01902***	0.1902***	0.054***
	(0.0582)	(0.0581)	(0.0582)	(0.0582)	(0.006)
IV2	-0.0137***	-0.0137***	-0.0137***	-0.0137***	-0.003***
	(0.0050)	(0.0050)	(0.0050)	(0.0587)	(0.001)
Controls + FEs	Yes	Yes	Yes	Yes	Yes
Total sales (ln, USD))	Yes	Yes	Yes	Yes	Yes
KP F-stat	106.3	106.7	126	126	42.95
Hansen J test (P-val.)	0.218	0.153	0.803	0.206	0.56
X_{it} + FEs (d_{jt}, d_l, d_k)	Yes	Yes	Yes	Yes	Yes
N	44,011	42,859	40,696	40,802	11,324

Note: * significant at 10%, ** significant at 5%, *** significant at 1%. Control estimates not reported. Standard errors are presented in parentheses, and are robust to heteroscedasticity and clustered by country-year of survey.

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