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Industrialization and Infant Mortality

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Industrialization and Infant Mortality

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On average, infant mortality rates are lower in more industrialized nations, yet health and mortality worsened during early industrialization in some nations. This study examines the effects of growing manufacturing employment on infant mortality across 274 Indonesian districts from 1985 to 1995, a time of rapid industrialization. Compared with cross-national studies we have a larger sample size of regions, more consistent data definitions, and better checks for causality and specification. We can also explore the causal mechanisms underlying our correlations. Overall the results suggest manufacturing employment raised living standards, housing quality, and reduced cooking with wood and coal, which helped reduce infant mortality. At the same time, pollution from factories appears quite harmful to infants. The overall effect was slightly higher infant mortality in regions that experienced greater industrialization.

Infant mortality rates today are much lower in industrialized nations than in nations with low rates of industrialization. At the same time, the great burst of British industrialization in the second quarter of the nineteenth was associated with “dark Satanic mills,” not improved health. Death rates did not decline and army recruits actually lost almost an inch (over 2 centimeters) in height (Steckel and Floud 1997). Similar declines in height accompanied industrialization for at least a generation in the United States. In contrast, several other nations have industrialized without a dip in health measures (Steckel and Floud, 1997: 425). A crucial question is whether industrialization in today’s poor nations is improving or reducing child health.

This study examines the effects of growing manufacturing employment on infant mortality across 274 Indonesian districts from 1985 to 1995, a time of rapid industrialization. Compared with cross-national studies we have a larger sample size of regions, more consistent

¹ Pitzer College and University of California, Berkeley, respectively. We appreciate comments from the BACPOP seminar, Berkeley. Jules Reinhart and Kok-Hoe Chan provided both data and insights.

data definitions, and better checks for causality and specification. We also explore the causal mechanisms underlying our correlations.²

Just as important as determining the overall correlation is understanding which causal channels connect industrialization and child health. For example, is industrialization beneficial because it raises incomes or living standards, harmful due to pollution, or both? If industrialization motivates urbanization, does the increased crowding help by moving children closer to health care providers or hurt due to higher exposure to disease? Understanding the underlying causal channels can help us understand what forms of industrialization are better or worse for child health and what policies may permit growth in both material standards of living and richer measures of development.

Links between Industrialization and Child Health

Children are exposed to pathogens in the air they breathe and the water they drink. The result is almost all children get respiratory illnesses such as colds and digestive problems leading to diarrhea. For a subset of children these diseases lead to death. Death is more common for children who are exposed to more pathogens; who have lower resistance due to malnutrition and lack of immunizations; and who lack health care after becoming sick.

Industrialization can affect the probability of mortality through each of the links in this chain, exposure to pathogens, resistance, and health care, in various ways. Most obviously, factories emit pollutants into the air and water. Such emissions are often heavy in poor nations such as Indonesia where pollution regulations are only weakly enforced. Air pollution is a major

² Our study follows the same cross-region methodology of historical studies such as that of Rogers, Brändström and Edvinsson, (2004). As with this study, they find that although early industrialization raised incomes, child mortality rates rose in Swedish region where sawmills were built. See also Potter, Schmertmann and Cavenaghi (2002), who examine fertility changes in Brazil as a function of local development.

contributor to the acute respiratory infections (for example, pneumonia) that are the most common cause of infant mortality (Romieu and others, 2002). Also, just bringing employees together in a large factory building can increase person-to-person transmission of pathogens.

Working in the opposite direction, industrialization may bring improvements in housing quality, sanitation, and household pollution, which can improve health outcomes. Similarly, factories bring jobs and rising incomes to a region which can improve nutrition for both mothers and children, in turn lowering death rates (Fogel 1994) and can also increase access to health care.

Finally, factories are also associated with urbanization. Living near others implies person-to-person and water-borne pathogens are more easily transmitted. Air pollution from cars is also worse in cities; Indonesia, for example, uses leaded gas and has limited pollution regulation. More beneficially, children in cities are usually closer to health care than are those in rural areas. In addition, cookfires – a major source of indoor air pollution – is less prevalent in urban areas.

The net result of all these forces is unclear from theory. Thus, we proceed to the data.

The Setting

Indonesia was one of the world's economic success stories with growth from 1967 to 1997 averaging 4.8 percent per year in real per capita GDP growth. The population living on one dollar a day dropped from 87.2 million in 1970 to 21.9 million in 1995. Other indicators of development showed great progress as well: literacy rates rose, immunization rates rose, and infant mortality declined. (World Bank 1999).

We study 1985 to 1995, a period of rapid industrialization just preceding the 1997-98 financial crisis. Figure 1 shows which districts experienced the greatest growth in manufacturing

employment. Much of the industrialization was concentrated in West Java near the capitol Jakarta. At the same time, there were concentrations of manufacturing growth spread throughout the diverse archipelago.

Methods

We compare changes across 274 Indonesian districts from 1985 to 1995 to examine whether infant health improved faster or slower in districts with faster growth of manufacturing employment. Our first specification assumes that the mortality of child i in household h in district d at time t depends on the presence of manufacturing employment in the household (mfg_{hdt}), average manufacturing employment in the district ($\%mfg_{dt}$), features of the child such as sex and months since birth (W_{ihdt}), features of the household such as its size and demographic composition (X_{hdt}), features of the district (Z_{pt}), and a random error (ϵ):

$$1) \quad \text{Mortality}_{hidt} = \alpha + \beta mfg_{idt} + \gamma \%mfg_{dt} + \varphi W_{ihdt} + \delta X_{idt} + \lambda Z_{dt} + \epsilon_{idt}$$

We assume the district characteristics Z are either observed (z_{dt}) or are constant over time and across a province (Z_p). Thus, we can eliminate all bias from unobserved province characteristics by adding a vector of province fixed effects (**Province_p**).³

$$2) \quad \text{Mortality}_{hidt} = \alpha' + \beta' mfg_{hdt} + \gamma' \%mfg_{dt} + \varphi W'_{ihdt} + \delta X'_{idt} + \lambda' z_{dt} + \lambda_p'' \text{Province}_p + \epsilon'_{hidt}.$$

This simple method would be appropriate if people never migrated and if factories located at random. Neither condition holds in Indonesia, leading to the complications we address below.

³ Although our data includes 60,000 births, the limited number of deaths spread out over districts of varying sizes means that there is not sufficient precision to include a complete set of 274 district dummies. Thus, we rely on the province dummies and district characteristics to capture geographic variation.

Time-Varying District Characteristics

A potential problem with this specification is that the provincial characteristics may not be fixed over time and may not be constant for all districts in the province. (Indonesian provinces are comparable to U.S. states. Provinces average about 10 districts, so typical districts are a bit larger than typical U.S. counties.) In the worst case, regions change over time in ways that affect both factory construction and infant mortality. For example, building a main road can both increase the region's attractiveness as a site for factories and reduce residents' costs of traveling to a health clinic as well as the odds that an infected person has visited a community recently. If we omit important time-varying district-level covariates Z_{dt} , then even with provincial fixed effects we will bias the estimates of interest, β' and γ' .

We address this potential problem of omitted factors by controlling for a number of potential factors likely to affect both infant mortality and industrialization. At the same time, these factors are potentially endogenous. For example, if manufacturing increases access to health clinics and health clinics reduce infant mortality, the increased access to health clinics may moderate the relationship between manufacturing and infant mortality. Thus, we add a variety of additional potentially endogenous factors at the district and household level to see if they change the estimated effects of industrial-sector employment in the household and district (β' and γ'). We consider district-level measures such as pollution, access to health care, and sanitation; and household level measures of housing quality, sanitation, and living standards. To repeat, some of these potentially moderating variables may have an independent effect on manufacturing employment. Thus, the causal interpretations of apparently moderating relations are discussed with care.

More concerns about causality

A separate set of statistical problems arises due to alternative causality underlying any effects estimated in equation (2). Two problems are possible: endogenous location of people (migration) and endogenous location of factories.

In Indonesia, as elsewhere, younger and slightly more educated people migrate toward factories. Fortunately, we can deal with the issue of migration because we know both the current district and the district of birth of our sample. We re-estimate our model classifying babies by the birth district of the mother. This classification ensures the results do not depend on non-random mothers moving to be near factory jobs. Finally, we rerun analyses dropping all families that have moved. We also use industrialization in a mother's birth district as an instrument for the industrialization of the birth district of her baby. The results below are robust to these various treatments of migration.

We are concerned that the correlations between household characteristics and manufacturing employment might not be causal because manufacturing does not select employees at random. In fact, in Indonesia both male and female manufacturing employees appear slightly advantaged prior to entering the labor force. Employees in manufacturing had .75 (for men) to 1 (for women) more year of education than others their age in the population. The above-average education makes it plausible that manufacturing employees also have above-average unobserved skills. If so, the regressions may over-state the causal effects of household-level manufacturing employment on living standards and child health.⁴

⁴ We also examine the earnings of manufacturing employees. This test captures more dimensions of skill than does education, but examines only the third of the work force who are employed in the formal-sector and, thus, report earnings. In addition, wages are also influenced by factors such as rent capture, which can lead manufacturing wages to be higher than justified by human capital alone. Conditioning on a set of 11 age-education interactions, men working in manufacturing had 9 percent ($P < .01$) higher monthly earnings than men working in

A final concern is if the arrival of factories is correlated with improved health, but the causality is reversed. For example, Jeffrey Sachs and Pia Malaney (2003) have argued that the high mortality and illness due to malaria discourages investment in a region. At the same time, malaria is a major cause of infant mortality. At least during the time period we studied, infant mortality was not a useful predictor of factory location. Appendix Table 1 presents a district-level regression that uses district characteristics to predict the growth in manufacturing employment from 1985 to 1995. Column 1 shows that manufacturing largely located where there were already factories and in urban regions. When we add infant mortality in 1985 (column 2), the coefficient is not statistically significant and the point estimate is small. If we drop initial manufacturing, baseline infant mortality remains unhelpful in predicting factory location (result not shown). Similarly, factory arrival is not correlated with existing health facilities.

Data and Measures

We analyze data from a variety of sources collected by Indonesia's Central Bureau of Statistics (BPS). Our main data source is the Supas Intercensal Population Survey, which we supplement with specific measures derived from the Susenas National Socio-Economic Survey, the PODES: Village Potential Statistics, and the Industrial Survey (SI). These data sets are described in Appendix 1. For all analyses we drop the (now-former) province of East Timor and the province known during this period as Irian Jaya. We also combine districts that merged or split between 1985 and 1995 to create a consistent series of districts. In our main analyses, we

other formal-sector jobs (although hourly wages were similar and statistically indistinguishable). The results were similar for women. The results on monthly earnings are reminiscent of results from many nations showing manufacturing jobs tend to be high-paying positions relative to the rest of the economy (e.g., Krueger and Summers 1998). In short, manufacturing appears to hire relatively individuals. (Recall these manufacturing employees in the household are almost entirely male as we do not include the mother)

link these district-level data from the various datasets with the district and household data from the 1985 and 1995 Supas (although some surveys are a year off of those dates). Summary statistics for all variables are presented in Table 1.

Manufacturing employment

We measure manufacturing employment with the Supas household survey. We count someone as a manufacturing employee if he or she works 20 or more hours a week as an employee or employer in the manufacturing sector. Thus, we eliminate the self-employed and family workers. At the district level, we measure total manufacturing employment among those aged 16-60 (male and females in manufacturing) as a share of total potential employment (total population aged 16-60). To control for possible changes in labor force participation due to industrialization, we focus on the change in manufacturing employment as a share of total adults, which has a smaller level but the same dramatic growth. From 1985 to 1995, manufacturing as a share of potential employment increased from 3.3 to 5.3 percent (1.9 to 3.4 percent for women only).⁵ Because not all adults work and because we exclude self-employed and family workers, these rates are lower than the manufacturing share of employment that is often published. Manufacturing employment as a share of the 1985 full-time economically active population (those unemployed or working over 20 hours per week) grew sharply from 6.3 to 13.1 percent.

We also measure manufacturing employment in the household. A household has a manufacturing worker if any adult age 18-60 other than the mother of the focal child works in manufacturing. Because we exclude the mothers, this measure is almost entirely men. For example, 5.7 percent of households with a birth had either a male or a female other than mother work in manufacturing. Among this group, 5.3 percent had an adult male while only 0.5 percent

⁵These rates are higher than those in Table 1 because they use sample weights to estimate the national averages.

had an adult female (other than the mother) in manufacturing. We are concerned about the endogeneity of manufacturing employment, where (for example) men who were already advantaged are more likely to have jobs in manufacturing. We test for such sorting below and consider how it may affect the reported results.

Infant mortality

We analyze infant mortality, defined as death of the child before reaching one year of age. Paralleling the rapid growth in manufacturing, infant mortality declined from 51 to 40 per thousand births from 1985 to 1995. This decline in only a decade represents very rapid improvement (although starting from quite high levels). We include only births that took place within the two years preceding each survey. In the 1985 Supas survey, respondents reported mortality for their last two births only (twins count as a single birth); thus, we restrict the Supas 1995 to the last two births as well.⁶ Finally, survey questions on births and infant mortality were only asked of ever-married women age 10-54.

Health Hazards from Factory Emissions

An ideal measure of how industrialization affects infants through pollution would require information on emissions of local factories, how weather and other factors affect the ingestions of hazardous chemicals by humans, and an understanding of how chemical uptake affects infants. Each of those pathways is challenging to measure. We proxy the pollution emitted in each district by the industrial composition of its manufacturing employment. As such, we are not measuring pollution from other industries such as agricultural pesticides and mine tailings. We combine employment at the 4-digit ISIC level from the SI industrial survey with pollution per

⁶ Because we are already restricting the sample to births in the last two years, few births are lost by restricting the sample to the last two births.

worker per industry constructed as part of the World Bank Industrial Pollution Projection System (IPPS, see World Bank 2001; 2005). Pollutants measured include gases and fine particulates in the air and amounts of toxic metals released to the land, air and water.

The IPPS data are based on industrial pollution in the United States at 1987 levels – a decision based on the quality and quantity of data in the US. The IPPS drew from the population of 200,000 US manufacturing firms spanning approximately 1,500 product categories, all operating technologies, and hundreds of pollutants. It incorporates a range of risk factors for human- and eco-toxic effects. These data were combined with economic information from the 1987 US Census of Manufacturers and the US Environmental Protection Agency's (EPA) information on air, water and solid waste emissions in 1987. The IPPS has been used to analyze data in countries as diverse as the Philippines, Mexico, Thailand, Latvia, and India (World Bank 2004).

To measure the toxicity of the predicted emissions, we use (the inverse of) 1996 threshold limit values (TLVs). TLV's are measures of safe toxic exposure levels as determined by the American Conference of Governmental Industrial Hygienists (ACGIH). They are intended to measure the time-weighted average concentrations in air that cannot be exceeded without adverse effects for almost all workers in a normal 40-hour work week. A weight of 1 implies a toxicity equivalent to 1mg of sulfuric acid per cu meter of air. Separate TLVs for the same chemical in different media were not given. All estimates were constructed using lower bound pollution intensities, largely due to greater data availability. (This paragraph is based on

<http://www.worldbank.org/nipr/data/toxint/>). We standardize the predicted pollution index so the average district has a value of 1 in 1985 by dividing by the 1985 mean.⁷

Health facilities

We analyze data on the number of health facilities per 1000 residents in the district, including integrated and supplemental health centers, maternity houses, and hospitals; and on the number of doctors per 1000 residents.⁸

There is substantial evidence that high-quality medical care can improve children's outcomes. At the same time, the quality of care in Indonesian health facilities is mixed and it is not clear that expanding low-quality care has much effect on children's outcomes. Moreover, the presence of a medical doctor in a clinic was not helpful in predicting children's outcomes or the quality of care (Barber and Gertler, 2002). Thus, the margins we examine – the density of clinics and of doctors – may not predict infant mortality strongly.

There is also concern about endogenous placement of facilities, where high need may lead to more facilities (Pitt, Rosenzweig, and Gibbons 1993; Molyneaux and Gertler 2000). When such causality is common, clinic density can often predict worse outcomes due to the decision to place clinics where outcomes are already low. We address this concern partly with our regional fixed effects and also by testing for endogenous placement explicitly. We find no

⁷ Our pollution index has a number of important limitations. It uses average emissions data from American plants in an industry in 1987 (after serious abatement efforts had begun) to predict Indonesian emissions (where regulations are frequently ignored). Furthermore, the measure ignores the differences among Indonesian plants. Emissions figures translate only approximately into human exposure because our index ignores factors such as the distance between a household and the plant, local weather and geographic conditions, the age of the polluting source, and whether the emission is to the air, land or water. Even when exposure is correct, the medical science translating exposure into biological harm for infants is often uncertain. In spite of these limitations, the pollution intensities have face validity. For example, the calculated industry-specific indices of pollution risk show it is more hazardous to be near a chemical or cement plant than an assembly plant.

⁸ Results were similar when we analyzed the various types of health facilities separately.

evidence that clinics locate in places with high or low infant mortality (Table 3A, columns 7 and 8).

Maternal and household characteristics

In most specifications we include a rich set of controls for characteristics of the mother (education, age and its square as well as dummies for mothers younger than 16 and older than 35, and age at first birth), the child (sex and dummies for months from birth to the survey date)⁹, the male head of household (age and its square, education, a dummy if absent) and the household (number of members, age composition, and the proportion of adults that are male). Because many of these characteristics are potentially endogenous (for example, if industrialization affects the age of first birth), we rerun specifications including only the predetermined variables of maternal education and infant sex and age; results are robust to this alteration (not shown).

Results: Industrialization and Infant Mortality

The main results of the paper are presented in Table 2. We present probit estimates of infant mortality, reported as marginal effects (how the predicted probability of enrollment changes with a one-unit change of the independent variable). Standard errors are adjusted for the clustering of observations at the district-year level and all regressions include province fixed effects.

The share of manufacturing workers in a district has a modest positive coefficient (.10, $P < .05$), implying that more manufacturing employment reduces child survival. Five percentage

⁹ Our sample includes babies who were born in the last 24 months and we examine survival up to age 12 months. Thus, we include dummies for each month since birth of 1 through 12, a dummy for age > 12 months, and a dummy for when month of birth is missing (year of birth is always present so we can detect infant deaths and survival). Results are unchanged if we drop children with missing month of birth.

points more manufacturing (as a share of the potential labor force) raises predicted infant mortality by 5 deaths per thousand, (a tenth of the 1985 mean). Any harm from a district's manufacturing is due solely to male manufacturing employment, as the female coefficient is of the opposite sign and larger (-.14, $P < .05$). Women are half the potential workforce, so an extra 1% of the potential female workforce working in manufacturing raises the manufacturing employment rate by 0.5%. The net effect of more female manufacturing workers is close to zero and not statistically significant.

A manufacturing worker in the household predicts slightly and not statistically significantly lower mortality -- consistent with the hypothesis that manufacturing pays above-average wages or with manufacturing employer selecting advantaged employees.

The coefficients on the control variables are generally of the expected sign. For example, infant mortality declines with both mother's and male head's education, while children of young mothers have higher mortality rates. Somewhat surprisingly, holding constant household size, infants are more likely to survive if the household has a higher share children and a lower share elderly (the omitted group). With the household controls, the year dummy is not statistically significant, implying that the 20 percent decline in infant mortality from 1985 to 1995 noted above can be accounted for by changes in household and maternal characteristics.

Causal channels

An important question is why district level manufacturing (at least among males) appears on net to increase infant mortality. We examine potential moderating channels that help explain the observed negative relationship, specifically the increase in pollution associated with rising manufacturing. In addition, we also consider potential channels through which manufacturing growth may actually improve infant health such as improved sanitation and living conditions. In

Table 3A, we first examine whether growth in manufacturing employment predicts the potential moderators. In general, results are as expected, with manufacturing growth correlated with rising pollution, improved living conditions and sanitation, and improved access to health care. In Table 4, we then see how conditioning on these potential moderating channels affects the estimated relation between industrialization and infant mortality.

While we measure many candidate causal channels, measurement of some elude us. For example, large-scale manufacturing may bring with it some incorporation of Western science and values. Child health is likely to improve as people learn the germ theory of disease and about the benefits of hand washing. Child health is likely to decline if crime rates increase, drug use becomes more common, or other ills of modern society become more prevalent.

Effects of Pollution

We focus first on our index of predicted industrial pollution which increases with manufacturing. We then turn to pollution generated by other households in the area (sanitation, etc.) which may improve if industrialization raises local living standards.

Manufacturing employment growth strongly predicts the growth in the index of predicted pollution (Table 3A, column 1). If manufacturing doubles as a share of the potential labor force (from its 1985 mean of 3.4% to 6.8%), the index of predicted pollution harm would be estimated to rise by 73%. This relationship is partly mechanical as the pollution index is based on manufacturing employment in each industry times the expected pollution in that industry. The correlation between manufacturing growth and growth in the pollution index is not one to one because Indonesia shifted toward industries with lower expected pollution per employee from 1985 to 1995. (We condition on the square kilometers of the communities in each district to help capture the dilution effects of larger districts.)

In spite of the coarseness of the index of expected pollution, the measure appears useful in predicting where manufacturing is harmful. Only those districts whose increased manufacturing employment was concentrated in those industries associated with higher pollution in the United States experienced meaningfully higher infant mortality (Table 4, column 2). To interpret the effect size, consider a district that started with the 1985 mean level of manufacturing employees distributed in industries with average pollution levels. Now consider what happens if its manufacturing employment grows to twice the national average and they now work in industries twice as polluting as average. Such a district would increase pollution from unity (standardized to be the 1985 mean) to 10. This very large increase in pollution would correspond to 11 more deaths per thousand live births – undoing the entire average decline from 1985 to 1995. Looking at smaller increases in pollution leads to smaller effects on infant mortality, but still highly statistically significant.¹⁰

At the same time, increasing manufacturing employment in industries that do not predict the pollution index had a very small and statistically insignificant effect on infant mortality (that is, the main effect on percent manufacturing in the district is now near zero and not statistically significant).

Next, we consider three measures of neighbor-generated pollution: cooking fires, lack of private toilets, and unsafe trash disposal. Improvements in two of the measures are correlated with the growth of manufacturing: slightly fewer people in the district living in villages where most people use firewood (Table 3a, column 2), and slightly more people living in communities where most people use a private toilet. The third measure, the share of the district who lives in

¹⁰ Results were similar, though (as expected) a bit weaker if we used tons of pollution instead of our weighted measure (using TLVs from American Conference of Governmental Industrial Hygienists index of expected harm per gram of each chemical) to create our index of expected pollution harm.

villages where most people have places to put their trash (as opposed to dumping it in the river or other disposal method such as burning) is uncorrelated with manufacturing changes (Table 3a, column 4). Thus, we do not test its role as a mediating variable. When we condition on the two candidate community pollution measures, having more people in communities where most people use a private toilet predicts slightly but statistically significantly lower infant mortality: 10 percentage points more people in such communities lowers infant mortality by 1 death per thousand live births. When conditioning on community firewood and private toilet use, the coefficient on district manufacturing gains statistical significance and rises from .10 to .15, although the increase is not statistically significant.

Industrialization and urbanization

Industrialization and urbanization are intertwined processes. As shown in Table 3A, column 6, growth in manufacturing is strongly correlated with growth in urbanization in a district, with causality almost surely running both directions. Factories bring migrants to urbanize a region and factories locate where potential workers are already concentrated; that is, in urban areas. Thus, any apparent effects of factories may partly be picking up the related phenomenon of urbanization.

We can bound the total effect of industrialization by removing the control for urbanization (Table 4, column 4). In that specification, the coefficient on manufacturing declines slightly from .099 to .088 (difference not significant). Thus, it does not appear that much of the link between manufacturing and infant mortality runs through the correlation of factories and urbanization.

Health facilities

We first examine whether growth in manufacturing predicted more clinics or doctors. We then explore whether the growth in clinics was a factor moderating the relationship between manufacturing growth and infant mortality. Manufacturing growth had a small but usually positive relationship with the number of health care facilities per capita. A 5 percentage point increase in total manufacturing (a large change) predicts .02 more doctors per thousand residents (about a sixth of the 1985 mean, Table 3A, column 7, $P < .10$), and .07 total health care facilities per thousand (a third of the 1985 mean, column 8, $P < .05$).

Though associated with increased manufacturing in the district, the number of medical doctors and the number of health facilities per thousand residents in a district does not correlate with infant mortality (Table 4, column 5). These results contrast with the more usual result that health facilities are useful (e.g., Frankenberg 1995). Because our measures of health care facilities are not correlated with infant mortality, including them in the regression has no effect on the estimated coefficients on industrialization.¹¹

There is a concern that facilities are built where needs are greatest (leading to a false negative correlation). At the same time, we have province fixed effects so that is unlikely to be the entire story. In addition, in our data 1985 infant mortality rates are not useful in predicting the growth of clinics (Table 3A, columns 6 and 7). While it always remains possible that new clinics were built in response to shocks to infant health, that possibility appears unlikely given lags in building and given Indonesia's budget-driven allocation of most health facilities. Thus, it is unlikely our results are strongly biased by endogenous program placement. Instead, our zero result may be due to the modest quality level of many Indonesian health facilities (Barber and

¹¹ Breaking down health care facilities into more detailed types does not change the result.

Gertler 2002) or may be due to our inability to match clinic building to specific communities (as was done by Frankenberg (1995) in her study of Indonesian clinic building during the mid-1980s).

Access to health care also increases when road quality increases. In results not shown, the effects of industrialization on infant health were not mediated by rising road quality.

Household Level Living Standards, Sanitation and Cooking Pollution

One possible benefit of increased industrialization is a higher standard of living at the household level. Industrialization both employs people directly and increases employment in related business services and among some suppliers too small to be picked up as manufacturing by our definitions. Higher incomes for these employed people can in turn increase employment for those who provide locally made goods and services. To the extent that migration or capital mobility takes time to equilibrate wages in different regions, industrialization in a local labor market will push up average incomes and living standards. Along with more nutrition and health care may come better sanitation and less pollution from cooking with wood or coal. We have proxies for each of these channels. Thus, we first examine which of these potential moderators are correlated with manufacturing; we next turn to see which correlate with infant survival.

Table 3B examines whether district and household manufacturing predict these household level characteristics: specifically, housing quality¹², having a private toilet, high-quality water source (pipe, pump or well, not a common surface source), electricity, cooking pollution (from wood or charcoal), the log of house size, and an asset measure (ownership of a TV, radio, stove and bicycle).

¹² Our index of housing quality is an index from 0 to 3 of the number of strong floor, roof and floor, where a strong floor is marble, ceramic, tile or brick (as opposed to wood, bamboo, earth, or other), strong walls are brick or wood (as opposed to bamboo or other), and a strong roof is concrete wood or tile (as opposed to asbestos, corrugated zinc, leaves, or other).

Housing quality, better sanitation (both having a private toilet and higher quality water source), electricity, and the number of consumer durables (the count of TV, radio, stove and bicycle) are all higher when a district has more manufacturing (Table 3b, columns 1-5). Similarly, the use of wood or charcoal as a cooking fuel (which maybe be associated with greater indoor pollution) is less common (column 6). At the same, houses are a bit smaller in high-manufacturing districts (column 7), consistent with high population density and property values near factories. Most of these improvements in living conditions are also associated with having a manufacturing worker in the household. Having a manufacturing worker in the household predicts higher assets and house quality fairly consistently as well as predicting lower use of wood or charcoal (Table 3B).

Because manufacturing generally predicts increases in these measures of material well-being, if we adjust for this improved house quality and the other measures of material well-being, we expect that district level manufacturing should predict even higher infant mortality than in our baseline (Table 2, column 2, reproduced as Table 4, column 1). That is, in fact, what we find. Manufacturing in a district is more strongly correlated with higher infant mortality when controlling for living standards than when not; the coefficient rises by a third from .10 to .13 (although the change is not statistically significant, Table 4, column 6).

As expected, cooking with a polluting heat source (wood or charcoal) predicts higher infant mortality. The increase is 5 deaths per thousand live births, or over 10 percent of the 1995 mean – a large effect.¹³ Similarly, a private toilet has a large beneficial effect as does a high-quality housing structure. Several of the measures related to prosperity such as floor size, the number of durable assets and a high-quality source of drinking water (pipe, pump or well) do not

¹³ Cooking fires might have an even stronger effect if we could break down those fires that occur indoors, as indoor fires are associated with the greatest health risks.

predict lower infant mortality by statistically significant amounts. Together, these results suggest that the measures with direct health effects (private toilet and low-smoke cooking) more than living standards in general matter for improvements in infant mortality.

Overall, the effect of manufacturing employment in the region rises from .10 to .13 when conditioning on these household characteristics (comparing Table 4 column 1 to column 6). The increase is economically meaningful although not statistically significant. Surprisingly, the effect of a manufacturing worker in the household remains small and not significant. Thus, it appears likely that the benefits of manufacturing that come in part from rising living standards (and less cooking over wood or coal, presumably due in part to urbanization) throughout the nearby region – not just among manufacturing employees themselves. As with the results on pollution from industry, manufacturing appears to be important due to its effects on pollution from households.

Finally, we expected that community-level poverty might lead to higher infant mortality. Manufacturing in a district predicts somewhat higher consumption among the poor (as measured by the 20th percentile of per capita consumption expenditures, measured from the SUSENAS survey, Table 3A, column 5). Surprisingly, a low level of consumption among the bottom fifth does not predict higher infant mortality (Table 4, column 7). Conditioning on this measure of poverty does not affect the estimated coefficient on manufacturing. Results were similar conditioning on median per capita consumption in each district (results not shown).¹⁴

¹⁴ We ran several robustness checks with no change in results. Results were qualitatively similar entering the mediating channels additively as when they were entered separately. Also, the baseline specifications include maternal and household characteristics that, as noted above, may be endogenous. In fact, changes in household composition are not strongly related to manufacturing growth (Federman and Levine, 2005). Nevertheless, as a robustness check, we reran the main results dropping all of these variables except maternal education (which is largely predetermined) and infant sex and age. Results were very similar to those presented in the text (results not shown).

Summary of results on potential causal channels

As pollution is harmful and living standards helpful to children, the overall effect of manufacturing on infant mortality is near where we started with all controls (Table 4, column 8). The residual harm is plausibly due to measurement error on pollution – an area of active research.

The Role of Direct Foreign Investment

Critics of globalization have emphasized the incentives that global firms have to shift high-emissions plants to poor nations. On the one hand, the economic logic of shifting highly regulated production to a region with weaker regulations is clear. On the other hand, there is no evidence that avoiding regulation is a measurable determinant of direct foreign investment (Levinson 2000). In addition, even if DFI plants are dirtier than the average plant in rich nations, they may still be cleaner than the average plant in their sector in poor nations. This lower level of pollution can be due to use of more modern technologies, better management that avoids costly leaks, higher visibility with regulators and the public in poor nations, and stronger concern for reputation in wealthy nations. Consistent with these stories, Eskeland and Harrison (1997) find that in four developing nations, DFI factories use less energy and use somewhat cleaner fuels than do locally owned plants in those industries. DFI might also help reduce infant mortality if foreign-owned plants pay above-average wages. Lipsey and Sjöholm, 2001, find such higher wages to be the case in Indonesia). Nevertheless, in some cases opponents of foreign investment have emphasized how foreign owned firms in China often ignore labor laws and can actually reduce wages and worsen labor conditions (see the many case studies in Kernaghan 1998).

We do not have plant-level data on emissions in Indonesia. The typical (that is, median) foreign-owned plant is in an industry with higher/lower {to be calculated xx} than the average domestically owned plant. This calculation ignores any higher or lower pollution that foreign-owned plants might produce compared to others in their industry. To the extent foreign-owned plants are more visible to regulators, visible to the Indonesian public, and more responsive to bad press from their home market, it is plausible they pollute less than otherwise similar locally-owned plants. To the extent foreign-owned plants are more capital intensive, they may create more output per employee. The corresponding increase in inputs may lead to more pollution per employee (even if not to more pollution per unit of output).¹⁵

In fact, the presence of foreign-owned firms in a district does not have a statistically significant excess effect on the harm that manufacturing employment does infants (Table 5, column 1). Neither the district share of manufacturing that is DFI nor the district DFI share interacted with district percent manufacturing is significant. At the same time, it is important to recall that even if foreign-owned manufacturing has no excess effect on infant health relative to other manufacturing, the main effect of manufacturing employment on infant mortality is negative. Thus, even an estimate of zero on the interaction is still consistent with foreign-owned plants being at least as hazardous as domestically-owned plants of similar employment.

¹⁵ Grant and Jones (2004) find no pollution gap among foreign- versus domestically-owned plants in the United States; evidence from less industrialized nations is lacking.

Conclusions

Summary

Infant mortality rates are slightly higher in regions with many manufacturing employees. This relationship appears related solely to growth in male manufacturing employment. Moreover, any harm is due to manufacturing employment in a region, not employment in the household. Factory location is uncorrelated with infant mortality rates in this sample and migrants are slightly advantaged (and results are robust to adjustments for migration) alleviating concerns that the observed negative correlation reflects factories locating in unhealthy regions or disadvantaged parents moving to be near factory jobs. The household correlations are statistically insignificant and also more suspect because manufacturing employees appear slightly advantaged in the labor market prior to their manufacturing job.

Much of the apparent harm factories do to infants appears related to factory pollution. At the same time, children benefit from the rising living standards associated with factories. Of particular importance are measures correlated with air pollution (lower firewood use at home and in the district) and person-created water pollution (more use of private toilets at home and in a district). Urbanization, in contrast, has little relationship with the manufacturing-mortality nexus.

Cautions

Much of our understanding of industrialization's effects on health comes from the vast and detailed historical research on British industrialization. At the same time, careful scholars have noted that such studies are just case studies of one industrialization – albeit the first. Two centuries later, it is worth examining more recent examples of industrialization to see how children fare. At the same time, it is important to recall that this, like its British predecessors, is

just a case study of one example of industrialization. It is possible that children in China or Mexico (to take two recent large cases) may have had quite different experiences than those in Indonesia as there are many possible reasons for industrializations to differ.

For example, Amartya Sen has noted that female employment sometimes increases female empowerment within the household (2001). If so, female employment may shift resources toward female goals, and these goals are frequently child-focused. At the same time, we would expect the importance of employment on female power to be lower in Indonesia than, for example, in much of India as women in Indonesia have traditionally had more authority than women in South Asian (Kevane and Levine 2002).

Indonesia during this period had a highly centralized tax and expenditures policy. Thus, a district that successfully industrialized and, thus, raised more tax revenue did not necessarily have substantially more to spend on health care or clean water. In nations with more decentralized fiscal policies, including Indonesia in recent years, the public health benefits of industrialization that increases tax revenue is likely to be larger. At the same time, if jurisdictions expend almost all of their potential revenue bidding for manufacturing plants, then total expenditures on health care and clean water can decline nationwide.

Finally, because we lack longitudinal data, we cannot examine the effects of manufacturing employment on the children of manufacturing employees. Factory jobs can increase exposure to chemicals, reduce the length of breastfeeding, raise incomes, and have many other important effects for good and ill. Future research should examine that important question.

Implications

Economists frequently define “industrialization” as “development” when we speak of “less industrialized” or “less developed” nations. At the same time, development is a much broader concept than building new factories. In a companion analysis, we find that increased industrialization in Indonesia was associated with modestly higher school enrollments and reduced work among young teens. Less optimistically, here we find that industrialization predicts slower declines in infant mortality.

We are able to decompose the effects of industrialization into two clear pieces: rising living standards help and industrial pollution hurts. In the broader debate on economic development, the refrain is often heard to industrialize first, and worry about pollution later. Our results give some cause for concern, and suggest it is important to look for cost-effective regulations at the regional level and to encourage rising incomes to be channeled into cleaner cooking methods and waste disposal at the household and community level.

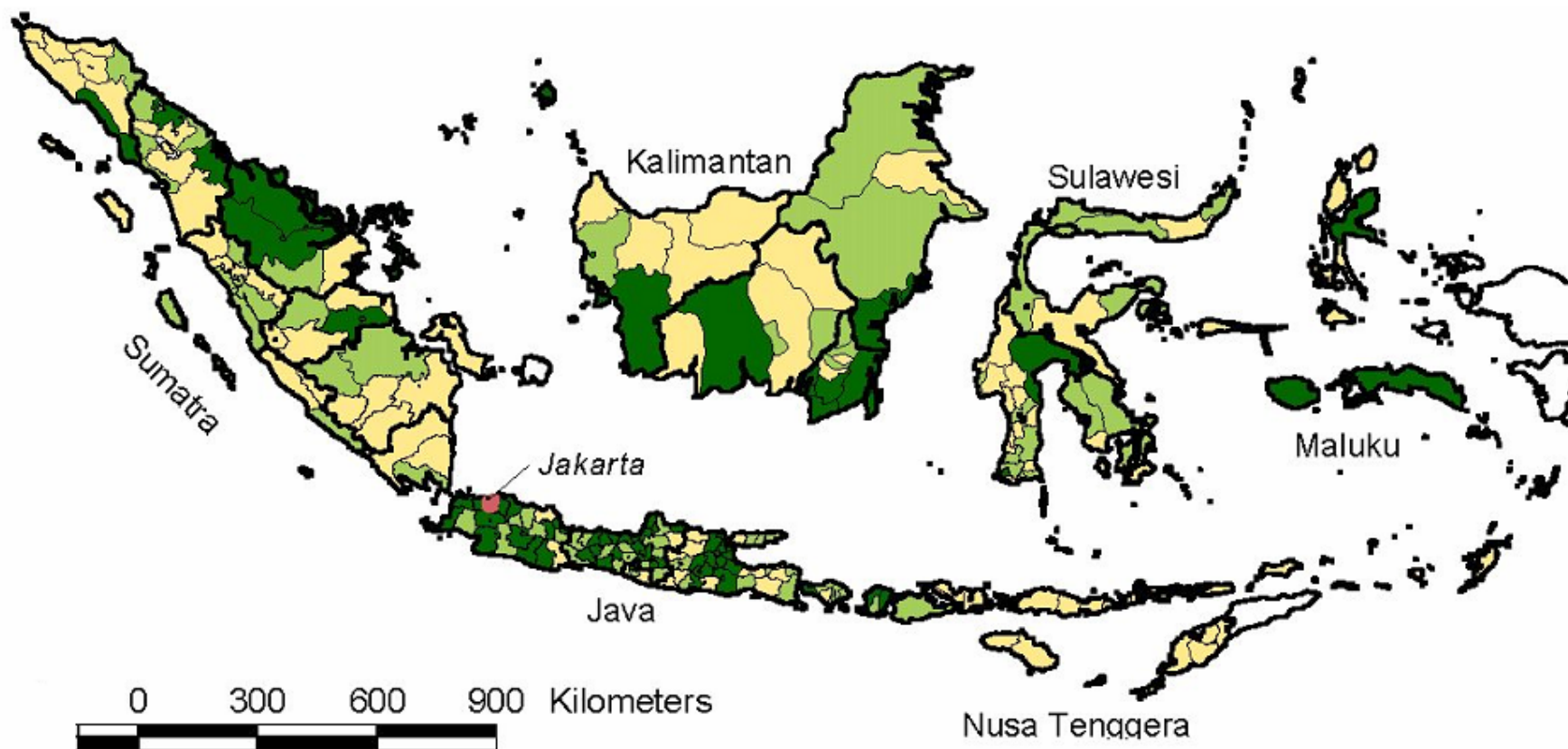


Figure 1: Industrial development in Indonesia, 1985-1995¹⁶

¹⁶ Percentage change in the proportion of manufacturing workers 1985 to 1995 among population aged 16-60 years, district averages, SUPAS. Light gray denotes the bottom third of districts in terms of percentage change in industrialization (that is, essentially none), gray denotes the middle third of districts, and dark gray denotes the top third of districts. The white areas on the map – East Timor and Irian Jaya – are excluded from the analysis.

Data Appendix

Supas: The Intercensal Population Surveys

The primary sources of data are the 1985 and 1995 Intercensal Population Surveys (Supas), each of which has responses from numerous households. The Supas 1995 contains data on more than 200,000 households and the Supas 1985 includes 124,000 households. The Supas sample was selected to be representative for each of Indonesia's roughly 300 districts. The survey over-samples smaller districts to increase precision.

Susenas: National Socio-Economic Survey

The National Socio-Economic Survey (Susenas) is an annually repeated cross section. It surveyed between 20,000 and 50,000 households per year in the mid-1980s and approximately 200,000 households per year by the mid-1990s. Sampling rules follow those of the Supas. We used the Susenas survey to obtain household consumption data and derive district consumption data for 1995.

PODES: Village Potential Statistics

The Village Potential Statistics (Podes) survey provides information about the characteristics of villages or urban neighborhood. Roughly 65,000 village heads complete the survey about their villages. Data on health facilities and neighborhood pollution were derived from the 1986 and 1996 Podes surveys. We average the village-level responses to the district level, weighting by population.

The Industrial Survey

The Industrial Survey is an annual census of employers with over 20 employees. Data on factories, employment, and direct foreign investment employment were derived from the 1985 and 1995 Industrial Survey.

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Table 1 - Summary Statistics

Individual/Household Variables				District Variables			
	Pooled	1995	1985		Pooled	1995	1985
Infant Mortality	0.047	0.042	0.053	Total predicted toxic chemicals in air/land/water, weighted by 1/TLV	1.72	2.44	1.000
	0.213	0.200	0.224	District % mfg of all workers	4.69	6.21	2.11
Mfg worker in HH	0.071	0.086	0.057	District % mfg of fem workers	3.2%	3.9%	2.5%
	0.257	0.280	0.232	% of district in vil with majority use firewood	3.7%	4.4%	2.8%
Log floor size	3.81	3.88	3.75	% of district in vil with majority have prvt toilet	2.0%	2.5%	1.4%
	0.58	0.63	0.52	% of district in vil with majority with trash in bin or sum of vil areas km2/1000	3.1%	3.6%	2.4%
Good structure = floor+roof+walls	1.69	1.86	1.53	Education of Adults (age 18-50)	72.6%	68.5%	75.8%
	0.98	0.96	0.97	Ln exp20	33.0%	33.7%	31.7%
TV+radio+stove+bike	1.76	2.14	1.38	Percent Urban	51.3%	51.7%	51.1%
	1.31	1.31	1.19	Health Facilities per 1000	29.4%	29.3%	29.5%
Private toilet	0.35	0.36	0.34	Doctors per 1000	63.4%	61.9%	64.8%
	0.48	0.48	0.47		28.1%	29.3%	26.8%
Piped, pumped, or well water	0.73	0.77	0.68		4.03	4.03	4.03
	0.45	0.42	0.47		6.7	6.7	6.7
Has electricity	0.47	0.67	0.28		6.3	7.1	5.4
	0.50	0.47	0.45		1.8	1.6	1.7
Cooking pollution (from wood or charcoal)	0.66	0.57	0.75		2.31	2.32	2.31
	0.47	0.49	0.43		0.27	0.26	0.29
Urban	0.31	0.38	0.24		28.7%	31.0%	26.4%
	0.46	0.49	0.43		31.7%	31.4%	31.9%
Girl baby	0.48	0.48	0.48		0.267	0.304	0.230
	0.50	0.50	0.50		0.19	0.220	0.145
Mom's education	6.05	7.18	4.93		0.113	0.135	0.092
	3.78	3.79	3.42		0.132	0.148	0.110
Mom's age	27.62	28.00	27.24		N=	548	274
	6.28	6.32	6.23				
Mom age 16 or less	0.007	0.008	0.007				
	0.085	0.089	0.082				
Mom age 35 or more	0.13	0.14	0.12				
	0.34	0.35	0.33				
Mom's age at 1st birth	20.90	21.37	20.42				
	3.72	3.87	3.50				
Total number of kids born	3.03	2.77	3.28				
	2.13	1.94	2.28				
Age of head	36.82	37.16	36.48				
	11.37	11.40	11.33				
Number of HH members	5.55	5.34	5.76				
	2.19	2.07	2.28				
Educ of male head	6.41	7.30	5.53				
	3.94	3.99	3.68				
No male spouse	0.040	0.039	0.041				
	0.196	0.193	0.199				
Prop adults in HH	0.49	0.50	0.47				
	0.16	0.16	0.16				
Prop kids in HH	0.49	0.48	0.51				
	0.16	0.16	0.16				
Prop of adults male in HH	0.48	0.49	0.48				
	0.11	0.11	0.12				

Table 2 - Predicting Infant Mortality

	(1)	(2)
District % mfg of potential workers		0.10179 [1.97]**
District % mfg of potential female workers		-0.13147 [2.04]**
Mfg worker in HH		-0.00289 [1.13]
Urban	-0.00272 [1.60]	-0.00294 [1.68]*
District Area (km ²)	-0.00005 [0.44]	-0.00005 [0.40]
Education of Adults (age 18-50)	-0.0024 [4.28]***	-0.00238 [4.16]***
Educ of Adults (-mean) squared	-0.00014 [0.97]	-0.00014 [0.94]
Girl baby	-0.00482 [4.09]***	-0.00481 [4.09]***
Mom's education	-0.00115 [4.85]***	-0.00115 [4.83]***
Mom's age	0.00127 [4.01]***	0.00127 [4.04]***
Mom's age (-mean) squared	-0.00007 [4.58]***	-0.00007 [4.58]***
Mom age 16 or less	0.14586 [8.25]***	0.14526 [8.24]***
Mom age 35 or more	-0.00801 [2.95]***	-0.00803 [2.96]***
Mom's age at 1st birth	-0.00139 [4.15]***	-0.00139 [4.16]***
Total number of kids born	0.01406 [15.43]***	0.01402 [15.39]***
Age of head	0.0005 [5.10]***	0.0005 [5.09]***
Age of head (-mean) squared	-0.00003 [5.55]***	-0.00003 [5.52]***
Number of HH members	-0.00723 [12.56]***	-0.0072 [12.52]***
Educ of male head	-0.00103 [4.62]***	-0.00102 [4.58]***
No male spouse	0.00523 [1.30]	0.00542 [1.35]
Prop adults in HH	0.02644 [2.56]**	0.02673 [2.59]***
Prop kids in HH	-0.20619 [18.11]***	-0.20596 [18.11]***
Prop of adults male in HH	-0.00119 [0.19]	-0.00108 [0.17]
Year is 1995	-0.00373 [2.37]**	-0.00379 [2.39]**
Observations	62595	62595

Notes: Probits reported as marginal effects (dp/dx) with province fixed effects and dummies for months between birth and the survey. Z-statistics robust to clustering at the district*year level.

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 3A: Does Growth in Manufacturing Employment Predict the Potential Moderators

	Growth in Pollution Index	Growth in % pop in village with firewood mainly	Growth in % pop in village with private toilet mainly	Growth in % pop in village with trashbin or hole mainly	Growth in 20th %ile ln(exp/ cap)	Growth in Urban	Growth in Doctors per 1000	Growth in health facilities per 1000
	1	2	3	4	5	6	7	8
Growth in total manufacturing	45.01 [2.74]***	-0.61 [1.23]	0.91 [1.03] ^a	0.23 [0.32]	1.55 [2.36]**	1.38 [2.43]**	0.479 [1.73]*	1.4509 [2.29]**
Growth in female manufacturing	1.24 [0.07]	-0.94 [1.69]*	0.89 [0.89] ^a	0.21 [0.26]	0.37 [0.50]	-0.02 [0.04]	-0.0007 [0.00]	-0.73262 [1.03]
Value of dependent variable in 1985	1.49 [13.46]***	-0.20 [4.14]***	-0.57 [11.87]***	-0.25 [4.95]***	-0.75 [17.61]***		0.142 [2.63]***	0.250 [3.71]***
Percent of district urban in 1985	-2.20 [3.33]***	-0.16 [3.67]***	0.38 [8.56]***	0.18 [5.74]***	0.32 [10.16]***	0.88 [38.61]***	0.062 [3.42]***	0.081 [3.09]***
District Area (km2)	-0.09 [2.26]**	0.003 [2.23]**	-0.003 [1.40]	-0.001 [0.58]	0.001 [0.52]	-0.001 [0.38]	0.001 [0.89]	0.003 [1.72]*
Infant Mortality in 1985							0.004 [0.04]	-0.023 [0.09]
Constant	0.26 [0.19]	0.118 [1.92]*	0.233 [3.18]***	0.070 [1.16]	1.603 [15.35]***	0.104 [2.22]**	-0.021 [0.87]	0.032 [0.54]
Observations	274	274	274	274	274	274	274	274
R-squared	0.63	0.31	0.58	0.33	0.66	0.91	0.46	0.3

Notes: OLS regressions with province fixed effects. T-statistics (in parentheses). Growth in district characteristics and manufacturing is measured as 1995 value -1985 value. * significant at 10%; ** significant at 5%; *** significant at 1%

Table 3B: Does Manufacturing Predict Household Characteristics

	Good floor+roof +walls (1)	Private toilet (2)	Piped, pumped, or well water (3)	Has electricity (4)	TV+radio+ stove+bik e (5)	Cooking pollution (from wood or charcoal) (6)	Log floor size (7)
District % mfg of all	3.253 [3.73]***	0.484 [0.97]a	1.079 [1.61]a	4.039 [5.46]***	4.585 [4.22]***	-4.34 [5.42]***	-1.334 [2.47]**
District % mfg of fem	-1.515 [1.53]	0.101 [0.18]a	0.441 [0.56]a	-1.686 [1.72]*	-0.989 [0.84]	2.485 [2.76]***	0.31 [0.54]
Mfg worker in HH	0.03 [2.34]**	-0.021 [2.29]**	0.04 [4.04]***	0.074 [5.56]***	0.076 [3.88]***	-0.026 [2.26]**	-0.057 [5.39]***
Urban	0.322 [17.68]***	0.229 [18.12]***	0.233 [16.96]***	0.406 [31.70]***	0.665 [26.56]***	-0.533 [40.21]***	-0.069 [4.83]***
Age of head	0.005 [11.90]***	0.005 [17.75]***	0.001 [3.15]***	0.003 [8.26]***	0.01 [17.32]***	-0.001 [3.10]***	0.007 [17.66]***
Age of head squared	-0.005 [2.48]**	-0.009 [6.19]***	-0.001 [1.11]	-0.008 [4.50]***	-0.018 [5.87]***	0.001 [0.35]	-0.014 [8.25]***
Number of HH members	0.03 [12.54]***	0.017 [9.03]***	0.001 [0.99]	0.023 [12.64]***	0.072 [22.53]***	0.002 [1.19]	0.065 [32.05]***
Educ of male head	0.056 [29.09]***	0.04 [35.99]***	0.013 [13.62]***	0.048 [44.86]***	0.099 [45.72]***	-0.042 [39.92]***	0.032 [24.68]***
No male spouse	-0.038 [2.13]**	0.007 [0.53]	0.016 [1.47]	0.003 [0.24]	-0.139 [5.47]***	-0.006 [0.45]	-0.013 [0.98]
Prop adults in HH	-0.091 [1.49]	-0.04 [0.98]	-0.017 [0.47]	-0.188 [3.88]***	0.127 [1.55]	-0.206 [4.10]***	-0.412 [8.89]***
Prop kids in HH	-0.212 [3.41]***	-0.171 [4.03]***	-0.035 [0.95]	-0.384 [7.41]***	-0.175 [2.14]**	-0.123 [2.35]**	-0.722 [15.18]***
Prop of adults male in HH	0.056 [1.93]*	-0.025 [1.26]	0.004 [0.19]	-0.02 [0.84]	0.104 [2.56]**	-0.017 [0.76]	-0.025 [1.15]
Year is 1995	0.147 [6.73]***	-0.094 [6.01]***	0.02 [1.29]	0.361 [23.75]***	0.423 [15.58]***	-0.049 [3.18]***	0.105 [7.40]***
Constant	0.479 [4.74]***				-0.737 [5.94]***		3.588 [49.93]***
Observations	59817	59817	59817	59817	59817	59817	58294
R-squared	0.46				0.43		0.22

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%, ^a jointly significant at 1%
t-stats, z-stats are robust to clustering at district*year level
Includes province fixed effects

Table 4: Causal Channels in Predicting Infant Mortality

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
District % mfg of all workers	0.102 [1.97]**	0.052 [0.95]	0.152 [2.77]***	0.090 [1.78]*	0.112 [2.10]**	0.133 [2.58]***	0.095 [1.78]*	0.108 [1.92]*
District % mfg of fem workers	-0.131 [2.04]**	-0.118 [1.74]*	-0.151 [2.32]**	-0.123 [1.93]*	-0.134 [2.08]**	-0.150 [2.38]**	-0.127 [1.97]**	-0.144 [2.11]**
Mfg worker in HH	-0.003 [1.13]	-0.003 [1.13]	-0.003 [1.16]	-0.003 [1.18]	-0.003 [1.16]	-0.003 [1.04]	-0.003 [1.12]	-0.003 [1.08]
Urban	-0.003 [1.68]*	-0.003 [1.61]	-0.001 [0.82]		-0.002 [1.31]	0.001 [0.42]	-0.003 [1.73]*	0.002 [0.86]
Total predicted toxic chemicals in air/land/water, weighted by 1/TLV		0.0004 [2.51]**						0.0004 [2.76]***
% of district in vil with majority use firewood			0.0068 [1.44]					0.0076 [1.33]
% of district in vil with majority have prvt toilet			-0.0089 [2.56]**					-0.0076 [2.23]**
Health facilities per 1000					0.008 [1.20]			0.0043 [0.68]
Doctors per 1000					-0.019 [1.64]			0.0014 [0.11]
Log floor size						-0.0002 [0.13]		-0.0002 [0.14]
Good structure = floor+roof+walls						-0.0023 [2.63]***		-0.0023 [2.66]***
TV+radio+stove+bike						-0.0002 [0.37]		-0.0002 [0.26]
Private toilet						-0.0031 [2.12]**		-0.0024 [1.65]*
Piped, pumped, or well water						0.0013 [0.87]		0.0015 [1.07]
Has electricity						-0.0016 [1.00]		-0.0014 [0.84]
Cooking pollution (from wood or charcoal)						0.0057 [3.15]***		0.0053 [2.86]***
Dist 20th percentile ln(expenditures/cap)							0.0026 [0.64]	0.0055 [1.37]
Observations	62595	62595	62595	62595	62595	62595	62595	62595

Notes: Probits reported as marginal effects (dp/dx) with province fixed effects, and the control variables in Table 2. Z-statistics robust to clustering at the district*year level.

Column (1) replicates results from Table 3, column 2

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 5: The Role of Direct Foreign Investment

	(1)	(2)	(3)
District % mfg of all workers	0.102 [1.97]**	0.103 [1.95]*	0.089 [1.67]*
District % mfg of fem workers	-0.131 [2.04]**	-0.130 [2.01]**	-0.128 [1.95]*
Mfg worker in HH	-0.003 [1.13]	-0.003 [1.12]	-0.003 [1.11]
Urban	-0.003 [1.68]*	-0.002 [1.39]	-0.002 [1.37]
Pct of Manufacturing Employment that is DFI		0.001 [0.27]	-0.003 [0.33]
Pct DFI * Proportion Manufacturing			0.112 [0.75]
Observations	62595	59123	59123

*Notes: Probits reported as marginal effects (dp/dx) with province fixed effects, dummies for months elapsed between birth and the survey, and the control variables in Table 2. Z-statistics robust to clustering at the district*year level. Column (1) replicates results from Table 3, column 2*

** significant at 10%; ** significant at 5%; *** significant at 1%*

Appendix Table 1: Predicting Growth in District Manufacturing

	(1)	(2)	(3)	(4)
District % mfg of potential wkrs in 1985	0.252 [4.32]***	0.252 [4.34]***	0.230 [3.93]***	0.231 [3.93]***
Percent Urban in 1985	0.005 [1.12]	0.004 [0.80]	0.011 [1.41]	0.011 [1.42]
District Area (km2)	-0.0004 [1.41]	-0.0004 [1.38]	-0.0004 [1.44]	-0.0004 [1.45]
Infant Mortality in 1985		-0.054 [1.22]	-0.045 [0.98]	-0.044 [0.96]
Education of Adults (age 18-50)			0.0098 [2.19]**	0.010 [2.19]**
Education of Adults (-mean) squared			-0.0009 [2.28]**	-0.001 [2.26]**
Health Facilities 1986				0.003 [0.21]
Constant	0.008 [0.90]	0.012 [1.20]	-0.015 [0.86]	-0.016 [0.88]
Observations	274	274	274	274
R-squared	0.31	0.32	0.33	0.33

Notes: OLS regressions with province fixed effects. T-statistics (in parentheses).

Growth in district characteristics and manufacturing is measured as 1995 value -1985 value. * significant at 10%; ** significant at 5%; *** significant at 1%