# Industrial Employment Densities[†]

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*Abstract*. This study examines the results of a long-running study of floorspace-to-employment ratios in U.K. industrial property. The objectives of the research were to identify the densities generated by a range of industrial building type and to gain a picture of how those densities move over time, in particular with relation to economic cycles. The research was empirical, taking a telephone survey of a quota sample delineated by size and location. The findings show clusters of densities by five different building types and postulates that the number of employees in employment is the main influence upon density.

## Introduction

The objective of this study is to present the latest results of a long-running survey of floorspace densities for properties in industrial use and to examine how the data collected relates to the broader economic circumstances prevailing throughout its collection. In this case floorspace density is defined as the number of square feet per person employed.

The data that forms the basis of this research has been collected on a regular basis over the past five years. Initial findings of the study were published in 1993 at the Royal Institution of Chartered Surveyors "Cutting Edge" conference.

Whilst there is already a body of work that looks at the same broad area of analysis, the conclusions that researchers have been able to draw have been limited by the samples chosen and none have approached the issues of changing densities over time—the areas that are addressed specifically here.

## Motivation

Employment data is collected frequently and in a structured manner. From standard, publicly available data we can determine the spatial and sectoral breakdowns. Employment is also one manifestation of demand for premises. With a quantifiable link between employment and property it should be possible to model likely demand for property by type. Furthermore it would be possible to model the employment impact of particular development configurations from a quantification of the floorspace involved.

Based upon this premise, over the past five years King Sturge research has been constructing and refining a general purpose development model for use at the master-planning stage which embodies the findings of this study.

In order to meet our modelling objective we needed therefore to establish:

- a range of employment density values generated by each of a set of building types;
- a clear indication of how those densities change over time, taking into account macroeconomic cycles and long-term trends.

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**Exhibit 1**
**Mean Densities by Property Type**

| Type | Mean Density |
|------|--------------|
| Factories | 383 |
| Factory/Warehouses | 461 |
| Warehouses | 631 |
| Long-term Storage | 1,283 |
| Workshops | 374 |

In particular we are seeking to establish an employment density factor that will be applicable at any point in the economic cycle enabling us better to project:

- impact on the local economy of a given development configuration;
- demand for property evident in a given employment forecast.

## Key Results

The significant results found by this study so far are as follows:

- As far as employment is concerned there are five subtypes of the industrial sector that may behave discretely. These are: factories; factory/warehouses; warehouses; long-term storage; workshops.
- Employees in employment is the main economic influence on each of the subsectors with the exception of long-term storage.
- There is no apparent link between changes in employment densities and the performance of the whole economy as embodied in indicators of Gross Domestic Product.
- The mean employment densities for factories and warehouses bear comparison with other indicators well and should provide relatively robust variables for development modelling.

## Methodology

As one of the U.K.'s leading firms of Chartered Surveyors, King Sturge & Co. has in-house a large volume of data about buildings, their locations, their tenants, and their physical dimensions. Equally, however, we do not hold details of the number of persons employed in these buildings.

The main thrust of the data capture has been therefore to identify the employment in each known building to derive an employment density. In its simplest form this is represented by:

$$\frac{Gross\ external\ area}{Number\ of\ full\text{-}time\ equivalent\ employees}.$$

## Sampling

A quota sample of individual buildings was chosen to replicate the size structure of the industrial property universe[1] from our database of properties valued. These were then screened to eliminate:

- properties vacant at the time of survey;
- properties not meeting the broad building-type criteria used by our small area model, i.e., Factory, Warehouse, Shed (combined Factory/Warehouse);
- properties where the current tenant details were unobtainable. Minimum requirements were for a name, a telephone number and a Standard Industrial Classification code.

The tenant of each "live" property was then contacted by phone. The nature of the research being undertaken was explained, confidentiality ensured and the number of full and part-time employees requested. In the analysis of the dataset, part-time employees have been converted to full-time equivalents in the ratio of 2:1.

Surveys have been taken in 1992, 1994 and 1996. Clearly, in order to assess employment densities over an economic cycle, repeat surveys on a core sample of properties have been necessary. The original 290 industrial buildings surveyed in 1992 have been surveyed again in 1994 and 1996 and will be surveyed in 1998.

The repeat surveys have proved problematic however. In order to pull out consistent time-series data the same tenant should be occupying the building throughout the series and ideally for the same purpose. Attrition through changes in tenant had reduced the core sample to 175 by 1996 and additional buildings have been surveyed to maintain the integrity of the original quota.

### Exhibit 2
### Sample Quotas

| Square Foot | Quota Proportion (%) |
| --- | --- |
| 1,000–2,500 | 25 |
| 2,500–5,000 | 20 |
| 5,000–10,000 | 17.5 |
| 10,000–20,000 | 15 |
| 20,000–50,000 | 15 |
| 50,000+ | 7.5 |

### Exhibit 3
### Sample Sizes

| No. of Buildings | 1992 | 1994 | 1996 |
| --- | --- | --- | --- |
| Whole Sample | 290 | 290 | 290 |
| of which Core sample | 290 | 201 | 151 |

The use category of the building was taken initially from our property records and no specific questions about use were asked. Changes in use were identified, however, from large changes in the floorspace densities from year to year. These further reduced the size of the core sample by eighteen.

Refusals to participate in follow-up on surveys were very few, but reduced the total by a further six, giving a 1996 core sample size of 151 buildings.

The secondary problem that arises from this attribution is that it focuses heavily upon the smaller property sizes, pulling the original quota distribution out of shape. This places limits on the interpretation of the analysis of repeat surveys and calls into question whether or not the repeat surveys planned for 1998 and 2000 should continue.

In total 510 industrial properties have been included so far in the study, representing over 10 million sq. ft of buildings and over 30,000 employees. Over the five years of the survey, positive response rates to the survey have been consistently high at 78%. Respondents have been either human resource managers or those responsible for that function.

## Expectations

Our work in this area and studies carried out for specific projects lead us to propose that employment densities vary widely according to the type of industrial use to which the building is being put. The usual nomenclature of "manufacturing" or "distribution" does not describe the building use at an adequate level for this type of analysis. Since our ultimate objective is to use this data at the planning stage of development, however, we do not want to disaggregate the data down to the level of the Standard Industrial Classification as has been attempted by other studies. In fact we are looking for clues from the distribution of the data as to the most appropriate level of analysis.

There is already a body of work that looks at the same broad area of analysis which draws out some conclusions.

### Density

Employment density in this study has been expressed as the ratio of employment to floorspace. Much of the town planning-led work in this area in the past has focused upon the ratio of employment to total site area. These studies suggest that warehouse employment correlates much less strongly with site area than with floorspace.[3]

McKinnon and Pratt, in various papers and articles, suggested that the average density in manufacturing was 366 sq. ft per worker, with 519 sq. ft per worker in warehousing

**Exhibit 4**
**Floorspace Densities**

|      | Manufacturing | Warehousing |
|------|---------------|-------------|
| Max. | 646           | 969         |
| Min. | 129           | 172         |
| Avg. | 366           | 519         |

*Source:* McKinnon and Pratt (1984)

**Exhibit 5**
**Densities by SIC**

| Activity | Use | Density (Sq. ft per worker) |
|---|---|---|
| Clothing & Footwear | Manf | 115 |
| Record Distribution Centre | W/H | 342 |
| Metal Goods | Manf | 625 |
| Cash & Carry | W/H | 753 |
| Chain Retailer | W/H | 767 |
| Electrical Engineering | Manf | 770 |
| Food Manufacturing | W/H | 815 |
| Long-term Storage | W/H | 3443 |

*Source:* McKinnon and Pratt (1984)

uses. These averages were within quite a wide range, however, indicating perhaps that use type was too general a category for analysis and that type of manufacturing, for example, would give a better picture of density. Indeed they attempt to undertake this exercise on a limited scale, highlighting various activities from their sample.

Various studies have identified other parts of the jigsaw. One in Greater London by the London Research Centre found a range of densities from 290 sq. ft per worker in Islington to 520 sq. ft per worker in Bexley (both are London Boroughs). The Hampshire County Council found 398 sq. ft per employee in manufacturing.

The preliminary findings of this study, published in 1993, found, on average, results for factories broadly comparable with those obtained by McKinnon and Pratt. The boundaries of the sample are wider but the raw average is in the same area, 385 sq. ft per employee compared to 366 sq. ft.

As far as warehousing was concerned, however, substantial differences were found with McKinnon and Pratt. The maximum density recorded was 2,303 sq. ft per employee compared with 519 in their study; minimum sizes were in the same area however. The weighted average comparable to McKinnon and Pratt is 647 sq. ft per employee.

## Time Series

The expectation was that employment densities would move broadly in line with economic cycles. This hypothesis was formed on the basis of the observation that as an economy improves, orders improve and more employees are hired to meet demand, in turn pushing down the area occupied by each employee. In this study the performance of Gross Domestic Product is used to represent the economic cycle and on this basis employment densities would be expected to fall by some 11% between 1992 and 1996.

Notwithstanding the impact of economic cycles, the results would also be expected to reflect the long-term decline in manufacturing employment experienced in the U.K. which would moderate any fall in employment density.

A more obvious linkage would be expected to be between employment density and employment data at the sectoral level, particularly employment in manufacturing and

**Exhibit 6**
**Overall Densities in Square Feet by Building Type**

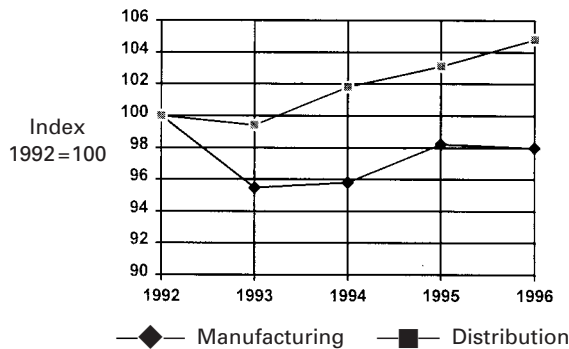| Use | Max. | Min. | Avg. |
|---|---|---|---|
| Factory | 712.0 | 58.3 | 385.2 |
| Factory/Warehouse | 942.2 | 107.9 | 525.1 |
| Mixed Use | 416.2 | 36.6 | 226.4 |
| Campus Office | 376.4 | 22.0 | 199.2 |
| Warehouse | 2303.0 | 253.0 | 1278.0 |
| Workshop | 768.6 | 22.5 | 395.6 |

*Source:* Thompson and Richmond (1993)

**Exhibit 7**
**Gross Domestic Product 1992–1996**
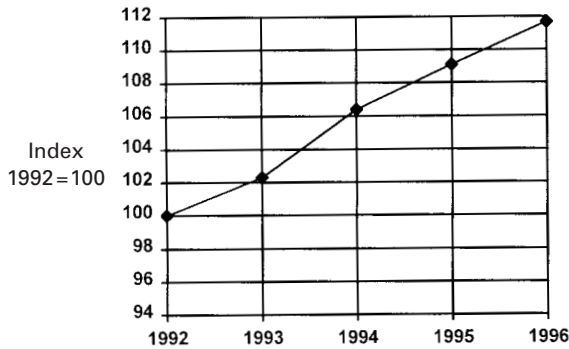


*Source:* Cambridge Econometrics

**Exhibit 8**
**U.K. Employment in Manufacturing and Distribution**



*Source:* Department for Education and Employment

wholesale distribution. On this basis the expectation would be that manufacturing employment densities would rise by around 2% between 1992 and 1996, whilst distribution employment densities would fall by around 5% over the period.

## Analysis

### *Property Type*

The distribution of employment densities within the dataset shows five clusters. These relate to five industrial property types.

- Factories — Buildings in which the main use is manufacturing.
- Factory/Warehouses — Buildings with a discernible proportion of warehousing usage as well as manufacturing.
- Warehouses — Buildings where the predominant use is storage and distribution. Typically these buildings are at the larger end of the spectrum, typically over 70,000 sq. ft.
- Long-term Storage — Buildings where the predominant use is long-term storage.
- Workshops — Buildings where the major use is for general, small-scale service use. In the sample these buildings tend to be below 5,000 sq. ft in size. Inevitably they will include some light manufacturing uses.

Three of these were envisaged by the original sampling exercise, but the data itself threw up the workshop and long-term storage categories.

Exhibit 9 shows that over the whole sample, including the core sample, for the five-year period the mean floorspace density for factory premises was 383 sq. ft per employee. This return is in the middle of the pack as far as previous research is concerned compared with 366 (Mckinnon and Pratt) and 398 (Hampshire County Council).

The return for warehouses at 631 sq. ft per employee however is some 20% higher than previous studies, compared with 519 (Mckinnon and Pratt) and 520 (London Research Centre). One possible explanation for this may be the dates at which the surveys were conducted: the Mckinnon and Pratt work was produced in 1984; the London Research Centre survey for the Department of the Environment was conducted in 1982.

The impact of technology has been particularly fierce in the distribution sector where very high employment densities are often the norm, particularly in the larger, purpose-

**Exhibit 9**
**Mean Densities by Property Type**

| Type | Min. | Max. | Mean Density |
| --- | --- | --- | --- |
| Factories | 58.3 | 736 | 383 |
| Factory/Warehouses | 90 | 992.6 | 461 |
| Warehouses | 226.2 | 1017.4 | 631 |
| Long-term Storage | 866.6 | 2023.1 | 1,283 |
| Workshops | 22.5 | 768.6 | 374 |

built facilities. Although there is no particular bias towards these large, national distribution centres in the sample, the overall trend has served to raise densities substantially throughout the distribution industry.

There is no real body of comparative work for the remaining industrial types identified. The return for workshops is very similar to that of manufacturing generally. This is unsurprising since workshop is often a euphemism for light manufacturing unit. The most defining characteristics of the subsector are that the buildings involved tend to be small, usually sub-5,000 sq. ft and the occupational profile changes reasonably quickly.

Long-term storage seems to have a stable employment density return over time—the returns are all tightly clustered around the mean. The characteristics of the subsector are that this is a small use in overall space terms, which tends to occupy secondary, often older space.

The behavior of mixed-use factory/warehouses—sheds for short—remains a puzzle. The return of 461 sq. ft per employee over the five-year period, whilst credible as being around the mid-point between factories and warehouses, has changed dramatically from the return on the 1992 survey of 565 sq. ft per employee. There is very little evidence, either anecdotal or from the survey, to explain this. The only possibility would seem to be that the category has been used as a catch-all in the past and as a consequence is somewhat less homogeneous that would be desirable for this sort of analysis.

*Cyclic Analysis*

Exhibit 10 shows the complete results of the surveys in all three years. Over time the factory employment density has remained remarkably stable given our initial hypothesis that this figure would move in line with economic activity.

The 1996 survey result at 390 sq. ft per employee is 1.3% up on the figure recorded by the initial 1992 survey. Yet 1992 was the low-point of the U.K. recession; four years into the recovery the occupiers of the manufacturing part of the core sample are employing fewer full-time equivalent employees. Clearly our expectation that the economic cycle, at least as measured in output terms, would relate to changes in employment density is not borne out by this data, since it would necessitate a fall in densities of around 11%.

The data is consistent however with our employment-based expectations. Overall there were nearly 70,000 fewer manufacturing employees in the U.K. at the end of 1996 than were working at the end of 1992. Using manufacturing employment as a proxy for the

**Exhibit 10**
**Employment Densities by Year of Survey**

|                    | 1992  | 1994  | 1996  |
|--------------------|-------|-------|-------|
| Factory            | 385   | 376   | 390   |
| Factory/Warehouse  | 525   | 419   | 439   |
| Warehouse          | 647   | 630   | 615   |
| Long-term Storage  | 1,278 | 1,275 | 1,296 |
| Workshop           | 396   | 372   | 354   |

**Exhibit 11**
**Changes in Density by Type**



Legend: —◆— Factory   —■— Factory/WH   —△— Warehouse   —✕— Long-term Storage   —✳— Workshops
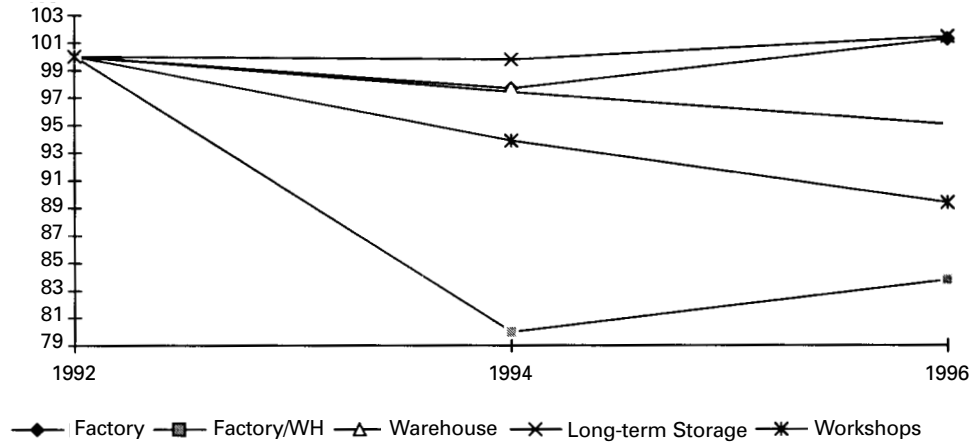
cycling of the manufacturing economy, we would expect a rise of around 2%. Whilst not exact, this looks to be a better measure for the factory property type.

The core sample of 151 properties shows a very similar pattern of change with a fall of 2% in 1994 and a rise of 4% in the 1996 survey. By comparison the factory/warehouse combination dropped dramatically over the course of the study from 525 sq. ft per employee to 419 in 1994, a fall of 20%, then rose back to 439 in 1996.

The pattern is difficult to explain but one of the contributing factors can be identified. The mean size of building in this property type is much smaller than for the overall sample at just under 3,000 sq. ft. This is the part of the sample where the quota has suffered disproportionately over time and it is likely therefore that the sample has become unrepresentative of the factory/warehouse universe. As if to confirm this, the core sample of used properties looks considerably less volatile, though following the same pattern.

The warehouse returns show densities falling consistently over the five-year period, overall and in the core sample—this, despite the ever-increasing impact of technology on the sector. This is consistent with anecdotal evidence from the market as to a great deal of demand for high-specification distribution centres at the end of the 1980s. Since then however the recession and slow recovery seems to have mitigated against rapid growth in this sector.

Workshop densities have fallen consistently over the five-year period by both measures as increasing employment feeds through to occupation. These buildings tend to be occupied by relatively small companies that are often the first to react to changes in economic circumstances and as a consequence are a genuine bellwether of the health of the industrial property markets.

The returns from long-term storage show a stable industry with little change as a result of any wider economic factors. In property terms these industries are the bottom-feeders, using up surplus building capacity, driven by price rather than specification.

## Conclusions

It is clear even from the limited time-series data, that there is little quantifiable link apparent between the macroeconomic cycle and employment densities overall—this, despite the fact that logic dictates that this should exist. One could speculate that the probability is that the relationship between the two variables is a complex one and is not being drawn out from this simple empirical survey.

However, at the level of individual property types, there are the beginnings of a relationship between employment data and densities. This is clearly demonstrable for those sectors where the breakdown of employment data matches the uses well, such as manufacturing and distribution. Without a more detailed breakdown of employment data this is less clear for the other subsectors identified by the survey.

This study pulls together the industrial sector results of a long-running survey. The original objectives of the survey were to provide employment density factors to King Sturge Research development models to allow us better to quantify the potential employment impact of developments and to better identify potential demand for floorspace from projections of employment. Has the study met these objectives as far as industrial property is concerned? The answer is a qualified *yes*. It shows that for the main industrial subsectors we have a robust quantification of employment density with a possible link to employment data—certainly enough to build a case. For mixed-use industrials and workshops the quantification is less robust, but nevertheless within the bounds of reasonableness.

Like all the best studies this one, whilst producing results, throws up a number of questions as well. It was intended to run this survey to 2000, i.e., to conduct two more surveys in 1998 and 2000, with the hope that a complete economic cycle could be captured. This would probably improve the results, but it would still prove difficult to establish a relationship between densities and, for example, employment, because of the relative shortness of the time series. The core sample will also be a problem for any further surveys; it has halved in size over the five-year period to the point where its usefulness is questionable. Clearly we need to find another route to a consistent time-series.

Finally, workshops and mixed-use sheds are reasonably large portions of the built industrial stock, especially by number. Their behavior in this survey has not proved to be consistent or explicable. Obviously more work needs to be done on these two subsectors before we understand their behavior.

## Notes

[1]The fact that these were all buildings valued at some time by the company could, under the strictest interpretation, affect the randomness of the sample, in particular, with respect to the perception that King Sturge & Co. deal predominantly with industrial property. In fact this market bias is true only of the agency function, if at all.

[2]The model takes account of other sectors in addition to those with an industrial component. These have been withdrawn for the purposes of this study.

[3]Peterlee Development Corporation (1980).

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