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# COMMUTING PATTERNS IN ISRAEL

# 1991-2004

**by**

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## Abstract

The paper examines commuting patterns in Israel within the gravity model framework. We find that commuting patterns of Israeli employees are close to their European and American counterparts: commuting rates are higher among younger and more highly educated employees, and men commute more than women. As is expected, we find that individuals more actively engage in commuting as the distance between regions decreases. Other things being equal, increasing the distance between origin and destination by 10 percent is associated with a 16 percent drop in commuting flow. Additionally, commuting flows are 3.4 times greater between the pairs of neighboring sub-districts. Moreover, higher wages and higher employment density (as measured by total employed to total labor force in the region) attract commuters. We also find that commuting is not necessarily directed towards the regions with the lowest unemployment.

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## Introduction

The commuting phenomenon is a kind of individual spatial behavior induced by geographic separation of living and working areas. Commuting has become one of the most prominent features of both modern labor markets and employees' lifestyle throughout the world. In 2000-2002 average commuting time in the former EU15 countries was 37.5 minutes per day, ranging from 29.2 minutes a day in Portugal to 51.2 minutes in Hungary (European Survey on Working Conditions). According to the U.S. Census Bureau, American employees averaged 48.8 minutes on daily trips to and from their workplaces[1].

Commuting in- and outflows are mostly unbalanced and eventually some regions turn into employment centers, attracting commuters from other areas, while others become residential ("sleeping") areas, in which a high percentage of residents are employed outside the region. A region's nature is determined primarily by its economic structure (important for its ability to attract commuters from other regions) and quality of living (which determines if individuals and households are able to find satisfactory residential facilities inside the region).

In general, commuting behavior is determined by three markets – labor, housing and transportation. Usually job seekers do not receive job offers requiring long commutes. As claimed by Zenou (2002), it is normally assumed that worker productivity falls with rising commuting distance, although there is no solid empirical evidence that "workers who have longer commuting trips are more tired and are thus less able to provide higher levels of effort than those who reside closer to the jobs" (p. 394). In the efficiency wages model framework he shows that once a firm determines critical (maximum) commuting distance, it will not recruit employees who live beyond this distance. As a result of the interaction between labor and housing markets, jobs can be filled only if the potential employees find satisfactory living arrangements within a reasonable distance to the workplace[2]. On the other hand, demand for housing is affected by existing employment possibilities in the region.

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[1] For details see Frey and Stutzer (2004), p. 30.

[2] An anecdotal evidence for increasing urban unemployment rates among Afro-Americans in the United States following job decentralization was presented by Kain (1968). Employment possibilities for Afro-American citizens deteriorated as they have not successfully settled in suburbs due to housing market discrimination.

This paper is organized as follows: the first four sections review some theoretical issues of commuting; section five summarizes commuting data in Israel; section six surveys Israeli research on commuting; section seven introduces the empirical model employed; section eight reports the results; and section nine presents the conclusions.

## 1. Basic commuting models

The theory of residential location, also known as the Alonso-Mills-Muth standard urban model, is widely used in research fields such as city planning, residential pricing, and commuting. It is based on a simple monocentric model developed by Alonso (1964), which provided a mathematical interpretation of the basic relationship between employment and demand for residential space, and analyzed the effect of distance from central business district (CBD) on housing prices, wages, and population density.

A simple monocentric urban model determines efficient locations for workers, when they are interested in minimizing commuting distance, taking into consideration certain living environment requirements. According to the model's assumptions, all jobs are geographically concentrated in the CBD; all employees are homogenous and commuting averse. Therefore demand for land in the central location is the highest and land for residential construction is sold in smaller lots and for higher prices than those in outlying areas. As the distance from the CBD increases (and commuting distance rises) lot size increases and the price of land per square unit decreases. Since residential possibilities in proximity to the CBD are limited, only some employees can afford to live near the workplace. The central outcome of the model is that individuals who at first show strong unwillingness to commute eventually decide to live a certain distance from their workplaces. Land shortage forces employees to reside outside the working area, and their disutility is compensated through cheaper and more spacious housing. Thus utility level equalizes for all individuals residing near and far from the CBD.

Replacing the basic, but unrealistic, assumption of homogeneity in tastes and incomes with a trade-off relationship between distance to city center and income provided equilibrium outcomes characterized by differences in commuting distances (Alonso, 1964, Muth, 1969, Beckmann, 1969). For example, the assumption of heterogeneity in household size caused geographical segregation of workers into concentric zones around the city center (Beckmann, 1972). Additional developments of the model include incorporation of time limits (Hekman, 1985) and job decentralization (Mills and Hamilton, 1984, White, 1988).

From the 19th century and until the middle of the 20th century, many American and European regions underwent an urbanization process of mass migration from rural to urban areas. But directly thereafter suburbanization started and many people returned to the hinterland. Accumulation of wealth, structural economic changes (especially de-industrialization) and expansion of private vehicle ownership after World War II were the guiding forces behind the decentralization of land use (Anas et al., 1998). In both the U.S. and Western Europe metropolitan settlement patterns changed from monocentric (where activities are centered in the core region and neighborhoods surround the core, while population density falls as distance to the center increases) to polycentric ones, where urban activities are decentralized and households move to suburbs or to the city edge (Forstall and Greene, 1997).

The transition to polycentric patterns was also caused by employee and employer preferences to settle in less crowded areas (Schwanen et al., 2004). Households moved to suburbs seeking cheaper and more spacious housing[3], while individuals continued holding jobs in the city centers. Firms that chose to lower expenses and escape restrictions on spatial expansion, while easing accessibility for employees living in the suburbs, found less dense locations. During the rapid economic growth of the 1990s many firms in the "new economy", especially those dealing in financial and business services, information and communication, chose to locate their businesses in urban margins or along highways (Atzema, 2001). Developments in infrastructure and public transportation allowed further suburban expansion. This reality caused researchers to criticize monocentric models and to propose alternative polycentric ones which were more successful in explaining the suburbanization process. As housing prices and population density near activity centers increase, the quality of life decreases, and residents of the center are inclined to move to suburban areas to find more suitable living arrangements (Greenwood and Stock, 1990, Van der Laan,

[3] For example, Renkow and Hoover (2000) found that recent expansion of the rural population was primarily due to new settlers who were seeking cheap housing.

1998). Employees living in the suburbs can choose between jobs in the city center, which require commuting, and jobs in the residential area (Nakagome, 1991, Turnbull, 1992).

## 2. Personal and social aspects of commuting

It is widely believed that commuting imposes economic burdens on employees, their employers and the whole of society. Commuting causes increased dependence on non-renewable energy sources while depleting natural resources, thereby intensifying the need for imports from the most politically unstable regions in the world (Ory et al., 2004). Geographic separation of residence and work place enforces costly investment, both physical and financial, to develop infrastructure and transportation which in turn causes negative externalities such as traffic congestion, noise and environmental pollution. Commuting also imposes extra expenses on households and the whole society. For instance in the U.S. the "typical household spends nearly 20 percent of its income on driving costs – more than it spends on food" (EPA, 2001). Research conducted by the American Transportation Research Board concluded that reducing commuting time by 10 percent may result in a saving of $350 million a year in the Chicago region and of $200 million a year in the Philadelphia region from increased productivity, a decrease in labor costs and the employer's ability to employ workers living within a wider area (NCHRP, report 463, 2001).

Even so, commuting may also contribute to regional economic development. In addition to accelerating the development of infrastructure, commuting can narrow regional disparities in wages and unemployment rates. Commuting flows facilitate an increasing labor supply in the center while decreasing that in the periphery. Thus they are a factor in narrowing regional wage gaps as wages decrease in the central cities and increase in peripheral regions. In his paper on the Baltic countries, Hazans (2004) documents that, as a result of commuting, average wage gaps between capital cities and rural areas decreased by 4 percent in Lithuania to 15 percent in Estonia, and wage gaps between capital cities and other cities decreased by 2 percent in Lithuania to 8 percent in Estonia and Latvia. Commuting may also reduce regional unemployment rate disparities. In Israel, increasing the out-commuting rate by 10 percentage points is associated with decreasing the unemployment rate in the region by approximately 0.3 percentage points (with t-statistic of 3.140), other things being equal (Presman, 2006). Therefore, out-commuting from regions with high unemployment should narrow unemployment rate gaps in local labor markets.

From the individual point of view, for most employees commuting is an emotional burden. Stressful environmental factors such as noise, crowdedness, air pollution, etc. are associated with negative psychological responses. Emotional tension causes high blood pressure, musculoskeletal disorders, increased frustration, anxiety and hostility, bad moods when arriving at work and when returning home, increased lateness, absenteeism, high job turnover, and adverse effects on cognitive performance (Koslowsky et al., 1995). In Germany, Frey and Stutzer (2004) discovered that individuals commuting longer distances systematically reported lower subjective well-being and did not reveal higher satisfaction from job or housing arrangements.

However, many commuters do not consider commuting to be a disaster[4]. As time goes by, they get used to traffic congestion, and higher incomes promote more acceptance of commuting and thus more mobility (Stopher, 2004). Increasing traffic congestion does not necessarily aggravate the individual commuting experience. Total congestion may be a result of a large number of relatively short "trips", which are far from being exhausting from the individual's point of view (Taylor, 2002). While the number of relatively small trips increases following employment expansion, thereby increasing aggregate congestion, individual commuting duration does not lengthen substantially. In some circumstances individual commuting utility may even rise, while the total social utility falls. For example, the individual commuter who exchanges public transport for private vehicle may shorten his personal commuting time at the expense of increasing aggregate congestion (Levinson and Kumar, 1994).

Furthermore the trip itself provides the commuter with time that can be used productively: while commuting, people may engage in various useful activities –

[4] For example, 82% of surveyed Californian residents answered that they were somewhat or very satisfied with their commuting activities (Baldassare, 2002). Another survey conducted in San Francisco Bay area revealed that 21% of commuters enjoyed their trips and half of those surveyed were satisfied with their commuting time (Ory et al., 2004). The American national representative survey showed that only 36% of those surveyed agreed that traffic congestion is the source of stress in their lives (Edmonson, 1998).

collecting information about the workplace or residential area, reading, listening to music, conversation, thinking, or even sleeping. A trip may also allow a temporary escape from individual problems and give the commuter a chance to be alone (Mokhtarian and Salomon, 2001), a possibility that may be extremely important for members of large households (Edmonson, 1998). This argument is strengthened by Ory et al. (2004) who found positive correlation between the number of adults in the household and the individual's desire to undertake longer commutes.

Getis (1969) suggested that individuals are indifferent to commuting distance as long as it does not exceed some maximum level. Some empirical findings reinforce this assumption. For example, So et al. (2001) found that U.S. non-metropolitan residents were ready to commute to the metropolitan area if the commuting time does not exceed one hour. Getis' theory can explain the lack of significant changes in commuting duration and distances with time. Thus Levinson and Kumar (1994) reported that the average commuting time in the Washington metropolitan area has not changed since the 50s.

For a given location of job and residence, individuals arrange their activities; thus a small change in commuting time will not significantly affect their lifestyle (Rouwendal and Nijkamp, 2004). On the other hand, substantial increase in the commuting distance will provide an incentive to change either workplace or place of residence. Zax (1991) investigated employee response to the employer's move from the city center to the city edge. He found that employees whose commuting distances substantially lengthened decided either to change their residential location or to quit following the shock to job-housing arrangements.

## 3. The substitution between migration and commuting

Both migration and commuting are motivated by regional disparities in income and relative employment opportunities (measured by regional unemployment rates) and are affected by relative conditions in regional housing markets. High income and diverse employment opportunities in a region are likely to encourage both in-migration and in-commuting. But while high housing prices discourage potential migrants from moving, they do not discourage commuting. When weighing options of migration vs. commuting, regional housing market conditions seriously affect decisions.

The principal difference between migration and commuting concerns the type of imposed individual costs. While migration incurs relatively high fixed costs, commuting imposes variable costs rising with distance (Jackman and Savouri, 1992). When commuting is a cheaper substitute for migration, the influence of housing prices on residential location strengthens and the influence of labor market conditions weakens (Cameron and Muellbauer, 1998). Therefore in reality we see much more commuting than migration. The commuting option explains the fact that net migration rates into central and employment rich regions are very low or even negative primarily due to relatively high housing prices.

Individuals are not used to moving their residences each time their labor market status changes. Thus residential mobility is substantially lower than employment mobility. For example, Manning (2003) shows that approximately 20 percent of workers have job tenure of less than a year, compared to only 10 percent of individuals who reside in the same place less than a year.

A survey prepared by Filler et al. (2001) shows low spatial mobility in all transitional countries. Since administrative barriers and underdeveloped housing markets prevent regional mobility, commuting becomes a more realistic substitute for migration. Given the considerably higher housing prices in central cities and the short distances in relatively small Eastern European countries, regional wage gaps may cause active commuting. For example, more than 40 percent of full time employees residing in rural areas in Latvia and Estonia and more than 60 percent in Lithuania are employed in urban localities (Hazans, 2004). According to the evaluation made by Boeri et al. (1996), acceptable commuting distances in transitional countries in Central and Eastern Europe do not exceed 30 kilometers. Kertesi and Köllö (1997) reached the same conclusion for Hungary, where they found that the "indifference point" is just 27 kilometers.

In most cases decisions to change a place of residence are "a last resort" when other alternatives have not worked out (Mokhtarian and Salomon, 1997). Reluctance to change a lifestyle is explained by the high costs associated with moving for an employee and his family members. Thus migration may be more complicated for households with multiple wage earners (Clark et al., 2003, Giuliano and Small, 1993, Van den Berg, 1992) due to the difficulties in finding appropriate permanent residential/job arrangements suited to both spouses.

## 4. Commuter characteristics

Since the value of time rises with income, urban economics predicts that resistance to commuting will be higher among highly paid employees. In reality residential style preferences of high-income individuals often impose limitations on their choices in the housing market; satisfying conditions that meet their workplace/residence requirements may be achieved in exchange for commuting (Rouwendal and Nijkamp, 2004)[5]. Since high-income earners are usually highly educated and possess specific skills, the labor market segment suitable for them is relatively "thin", with spatial dispersion of jobs more prominent than those in low-wage labor markets. Therefore, as opposed to a simple model prediction, it can be expected that highly educated and high-income earners would be overrepresented among commuters. But the relationship between commuting and income must be a reciprocal one; since commuting incentives rise with higher income levels in other regions, the commuters' average earnings are higher than those of non-commuters. There is plenty of empirical evidence to support this assumption. While estimating the wage equation for employees of a single firm, Zax (1991) added commuting data and received a positive coefficient. In the Baltic countries, commuters' earnings are higher than those of identical non-commuters by 16, 11 and 20 percent in Latvia, Lithuania and Estonia, respectively (Hazans, 2004). Cameron and Muellbauer (1998) found in British Labor Surveys that commuters' earnings are higher by 62%, on average, relative to those of non-commuters'. In Germany, Frey and Stutzer (2004) concluded that commuters with commuting times of 23 minutes in one direction (average time in their survey) have to receive monthly average premiums of 19 percent to fully compensate them for their time loss. Zenou (2003) developed an urban monocentric efficiency wage model,

[5] In the dense centers of old cities, it is not possible to satisfy an excessive demand for housing by housing stock expansion. But, it can be made easier and much cheaper on the city edge or in the suburbs.

in which wage rate rises with commuting distance. The fact that wages rise with commuting time and length was documented in several empirical studies (e.g. Manning, 2003, for Britain and Madden, 1985, for the U.S.).

Commuting costs are also influenced by age, the number of children in a household, gender and non-labor income. The probability of employment outside the residential locality falls with age (Ory et al., 1998, Hazans, 2004, So et al., 2001). Younger individuals prefer bigger houses for larger families and accept longer commuting distances. Older employees are less eager to commute and can often afford to change workplace or place of residence to shorten commuting distance. Commuting is more complicated for families with children, when parents need to combine work with child care (So et al., 2001). Non-labor income increases the demand for leisure and reduces the incentive to commute long distances. Thus commuters have less non-labor income, while people with higher non-labor income tend to reside in metropolitan areas (So et al., 2001). Commonly, suburban residents commute more than city residents (Ory et al., 1998). Commuting is frequent in developing regions where problems of matching the demand with the supply of skills necessitate commuting more than in established, economically developed regions (Van der Laan, 1998).

A consistent finding of commuting studies is that commuting duration and length for females are shorter than for males. Early evidence for this is found in the papers by White (1977) and Madden (1981). Several studies reported that commuting distances are longer for married relative to single men and that women's commuting distances are shorter than those of their husbands (e.g. Gordon et al., 1989). Van den Berg and Gorter (1997) find significant gender differences in willingness to accept jobs far from home, especially when there are young children in a household. It is widely believed that men and women have different evaluations of the inconveniences caused by commuting. The differences are often explained by lower wages for women, their obligations to combine a job with household duties and child care, and more uniform spatial distribution of jobs common among women (MacDonald, 1999). Household and child care responsibilities are more problematic for women with long commutes and increase time value, even though their wage rates are lower (Brownstone and Small, 2002, Hanson and Pratt, 1995).

## 5. Commuting patterns in Israel

All data concerning commuting behavior was derived from Labor Force Surveys. To multiply the number of observation units we used an administrative division of the Israeli economy into 16 sub-districts (for details and map see Appendix A). Since sub-districts differ in size, our definition of commuting as one that takes place *between sub-districts* underestimates commuting in the relatively large regions and overestimates it in the relatively small ones. We can't overcome this drawback, because we do not have exact data on the locality of workplace. Instead, we have only sub-district of workplace indicator. It has also to be noted that most sub-districts are too small to be considered independent local labor markets.

Due to Israel's relatively small economy, commuting is a fairly wide-spread phenomenon; more than 40 percent of workers are employed outside their residential locality and almost 30 percent of all workers are employed outside their residential sub-district. The data in Table 1 demonstrates that during the period 1991-2004 commuting rates tended to accelerate. Thus, the proportion of those employed outside the residential locality increased by more than 10 percent (from 40.3% of all employed in 1991 to more than 45% in the 2000's) and the proportion of those employed outside the residential sub-district increased by almost 9 percent (from 26.8% to 29.4% of all employed persons in 1991 and 2004, respectively).

Tables 2-3 report separate commuting flows: out-commuting, which is the proportion of those employed outside the residential sub-district out of all employed residents, and in-commuting, calculated as the number of employed non-residents divided by all employed persons within a sub-district. Table 4 summarizes the net commuting balance sheet, i.e. displays the number of in-commuters less out-commuters (employed persons, in real numbers).

*Table 1 – Distribution of Israeli employees, by workplace, percent of all employed*

| Year | Employed within locality of residence (1) | Employed outside locality of residence but within sub-district of residence (2) | Employed outside sub-district of residence (3) | Employed outside locality of residence (2)+(3) |
|---|---|---|---|---|
| 1991 | 56.3 | 13.5 | 26.8 | 40.3 |
| 1992 | 56.5 | 13.5 | 27.2 | 40.6 |
| 1993 | 55.6 | 14.4 | 27.2 | 41.5 |
| 1994 | 55.7 | 13.9 | 27.5 | 41.4 |
| 1995 | 54.9 | 14.7 | 27.7 | 42.4 |
| 1996 | 54.1 | 15.8 | 27.8 | 43.6 |
| 1997 | 54.3 | 15.7 | 27.6 | 43.2 |
| 1998 | 54.3 | 15.1 | 27.8 | 42.9 |
| 1999 | 52.8 | 16.2 | 28.8 | 45.0 |
| 2000 | 52.0 | 15.6 | 29.6 | 45.2 |
| 2001 | 51.3 | 15.8 | 29.6 | 45.4 |
| 2002 | 52.1 | 15.9 | 29.1 | 45.0 |
| 2003 | 51.9 | 16.0 | 29.4 | 45.4 |
| 2004 | 51.1 | 15.9 | 29.4 | 45.3 |
| **Average** | **53.8** | **15.1** | **28.2** | **43.4** |

*Source: Calculations of Labor Force Surveys, various years, CBS.*
*Note: Columns (1)+(2)+(3) do not add up to 100% due to "works in different places", "works abroad" and "unknown" categories.*

*Table 2 – Out-commuting, as percentage of all those employed within sub-district*

| Sub-district | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | Average 1991-2004 | Std 1991-2004 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Jerusalem** | 5.2 | 5.3 | 4.7 | 4.4 | 4.6 | 5.0 | 5.1 | 6.1 | 6.2 | 6.2 | 5.3 | 6.6 | 7.1 | 6.1 | **5.6** | **0.8** |
| **Zefat, Kinneret** | 7.1 | 7.2 | 8.0 | 6.5 | 5.0 | 6.4 | 6.4 | 6.7 | 7.9 | 7.1 | 8.5 | 10.2 | 9.3 | 8.9 | **7.5** | **1.4** |
| **Yizre'el** | 15.2 | 17.6 | 21.4 | 20.6 | 21.9 | 21.9 | 21.3 | 18.6 | 20.5 | 20.0 | 18.9 | 18.9 | 21.4 | 23.3 | **20.1** | **2.1** |
| **Akko** | 26.4 | 27.3 | 29.5 | 29.2 | 30.6 | 28.5 | 28.5 | 25.8 | 24.9 | 27.8 | 25.3 | 26.1 | 27.3 | 27.6 | **27.5** | **1.7** |
| **Haifa** | 7.7 | 8.5 | 8.9 | 7.4 | 8.6 | 9.4 | 10.6 | 10.8 | 11.0 | 11.5 | 13.4 | 12.9 | 11.5 | 12.8 | **10.4** | **2.0** |
| **Hadera** | 22.8 | 27.4 | 27.8 | 29.3 | 29.5 | 27.5 | 28.2 | 30.4 | 30.3 | 31.8 | 32.1 | 29.1 | 32.8 | 32.2 | **29.4** | **2.6** |
| **Sharon** | 29.9 | 30.6 | 32.3 | 32.4 | 31.4 | 33.2 | 33.8 | 33.7 | 33.4 | 36.2 | 33.0 | 31.3 | 31.1 | 34.4 | **32.6** | **1.7** |
| **Petah Tiqwa** | 44.7 | 44.4 | 43.8 | 43.9 | 43.0 | 42.7 | 42.0 | 41.7 | 42.8 | 42.4 | 44.1 | 41.8 | 41.9 | 40.3 | **42.8** | **1.3** |
| **Ramla** | 36.2 | 42.0 | 46.2 | 43.0 | 39.7 | 40.5 | 39.1 | 45.4 | 48.2 | 48.6 | 45.7 | 46.4 | 44.7 | 47.5 | **43.8** | **3.8** |
| **Rehovot** | 42.6 | 41.2 | 43.0 | 42.5 | 42.2 | 43.9 | 43.5 | 41.8 | 44.6 | 45.5 | 44.3 | 43.6 | 45.5 | 44.7 | **43.5** | **1.3** |
| **Tel Aviv** | 19.3 | 19.6 | 20.5 | 19.4 | 22.3 | 22.6 | 20.8 | 20.9 | 24.1 | 24.5 | 26.1 | 26.0 | 25.9 | 26.3 | **22.7** | **2.7** |
| **Ramat Gan** | 55.9 | 55.1 | 55.9 | 54.8 | 52.4 | 54.0 | 52.4 | 51.9 | 54.7 | 54.3 | 52.9 | 52.7 | 53.7 | 53.3 | **53.9** | **1.3** |
| **Holon** | 62.9 | 62.7 | 63.0 | 63.8 | 62.2 | 61.3 | 61.2 | 59.8 | 61.7 | 63.3 | 64.6 | 60.3 | 61.3 | 60.6 | **62.1** | **1.4** |
| **Ashqelon** | 14.4 | 15.6 | 18.1 | 19.0 | 20.3 | 22.3 | 23.1 | 21.5 | 20.7 | 21.6 | 24.7 | 22.6 | 22.0 | 22.1 | **20.6** | **2.9** |
| **Be'er Sheva** | 3.7 | 3.6 | 4.6 | 4.6 | 3.7 | 3.9 | 5.3 | 5.6 | 4.7 | 4.9 | 6.0 | 4.8 | 4.1 | 4.9 | **4.6** | **0.7** |
| **Judea and Samaria** | 57.4 | 52.4 | 51.4 | 57.7 | 56.4 | 51.8 | 56.1 | 56.8 | 54.6 | 58.5 | 58.9 | 59.0 | 59.4 | 54.5 | **56.1** | **2.7** |

*Source: Calculations of Labor Force Survey, various years, CBS.*

*Table 3 – In-commuting, as percentage of all those employed within sub-district*

| Sub-district | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | Average 1991-2004 | Std 1991-2004 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Jerusalem** | 9.4 | 8.9 | 9.4 | 10.8 | 11.0 | 11.6 | 12.1 | 11.6 | 14.4 | 16.1 | 15.4 | 15.1 | 15.0 | 16.5 | **12.7** | **2.7** |
| **Zefat, Kinneret** | 12.0 | 12.0 | 14.6 | 13.7 | 18.2 | 14.7 | 14.8 | 17.0 | 13.2 | 13.3 | 14.3 | 15.8 | 17.0 | 13.7 | **14.6** | **1.9** |
| **Yizre'el** | 11.3 | 8.4 | 10.2 | 9.6 | 9.2 | 9.8 | 12.1 | 12.5 | 12.7 | 14.1 | 15.2 | 16.4 | 13.9 | 15.6 | **12.2** | **2.6** |
| **Akko** | 8.1 | 9.9 | 13.0 | 9.9 | 9.1 | 10.2 | 11.5 | 11.4 | 10.9 | 11.2 | 11.6 | 9.8 | 8.5 | 11.1 | **10.4** | **1.3** |
| **Haifa** | 17.8 | 19.4 | 20.6 | 19.6 | 20.9 | 20.5 | 21.2 | 19.6 | 20.2 | 20.8 | 19.1 | 19.5 | 21.2 | 21.3 | **20.1** | **1.0** |
| **Hadera** | 11.6 | 12.9 | 14.6 | 16.0 | 15.6 | 16.8 | 11.9 | 11.9 | 11.1 | 13.3 | 15.0 | 15.5 | 16.3 | 16.5 | **14.2** | **2.0** |
| **Sharon** | 11.4 | 14.0 | 14.1 | 15.1 | 15.3 | 15.8 | 15.3 | 16.8 | 20.5 | 21.2 | 22.6 | 23.1 | 22.1 | 22.8 | **17.9** | **4.0** |
| **Petah Tiqwa** | 28.5 | 28.8 | 29.8 | 27.6 | 28.1 | 30.4 | 30.7 | 31.6 | 34.6 | 35.1 | 37.4 | 35.7 | 35.6 | 35.5 | **32.1** | **3.4** |
| **Ramla** | 54.5 | 58.1 | 60.2 | 56.3 | 52.8 | 54.9 | 51.7 | 50.1 | 51.7 | 51.0 | 51.0 | 49.0 | 49.5 | 52.5 | **53.1** | **3.3** |
| **Rehovot** | 22.6 | 23.1 | 25.8 | 25.9 | 26.1 | 28.4 | 28.8 | 25.1 | 26.7 | 30.0 | 30.4 | 30.6 | 31.4 | 30.2 | **27.5** | **2.9** |
| **Tel Aviv** | 55.8 | 56.4 | 56.2 | 55.6 | 56.3 | 55.8 | 55.7 | 57.8 | 58.9 | 58.9 | 58.6 | 57.9 | 58.2 | 57.6 | **57.1** | **1.3** |
| **Ramat Gan** | 44.4 | 47.0 | 47.8 | 49.3 | 48.9 | 49.0 | 48.5 | 48.3 | 51.5 | 49.8 | 50.1 | 50.9 | 52.7 | 52.0 | **49.3** | **2.2** |
| **Holon** | 30.9 | 27.5 | 29.7 | 29.5 | 31.8 | 33.8 | 30.2 | 31.8 | 34.8 | 37.0 | 37.0 | 35.5 | 34.7 | 35.5 | **32.8** | **3.0** |
| **Ashqelon** | 14.1 | 13.4 | 12.7 | 12.6 | 11.1 | 12.3 | 13.3 | 13.3 | 13.8 | 15.7 | 15.3 | 12.7 | 14.2 | 13.9 | **13.5** | **1.2** |
| **Be'er Sheva** | 5.2 | 4.7 | 3.9 | 4.6 | 5.2 | 5.2 | 3.9 | 3.9 | 3.2 | 4.0 | 4.3 | 4.3 | 4.4 | 4.4 | **4.4** | **0.6** |
| **Judea and Samaria** | 15.3 | 16.6 | 10.2 | 14.1 | 22.1 | 18.8 | 23.6 | 23.5 | 23.1 | 23.4 | 21.9 | 22.2 | 24.7 | 20.3 | **20.0** | **4.3** |

*Source: Calculations of Labor Force Surveys, various years, CBS.*

*Table 4 – Commuting balance sheet: in-commuting minus out-commuting in real numbers*

| Sub-district | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Jerusalem** | 8,180 | 7,389 | 9,141 | 13,593 | 13,940 | 14,488 | 15,925 | 13,401 | 19,395 | 24,541 | 25,891 | 21,521 | 21,052 | 28,680 |
| **Zefat, Kinneret** | 2,316 | 2,444 | 2,535 | 4,237 | 7,975 | 5,832 | 5,741 | 7,184 | 4,236 | 4,638 | 4,111 | 4,021 | 5,747 | 3,319 |
| **Yizre'el** | -3,311 | -9,104 | -10,469 | -12,327 | -15,627 | -15,481 | -12,245 | -7,916 | -9,060 | -7,806 | -4,811 | -3,089 | -10,921 | -11,471 |
| **Akko** | -18,937 | -19,170 | -18,566 | -23,138 | -28,388 | -24,699 | -22,466 | -20,781 | -19,010 | -22,722 | -19,495 | -24,143 | -29,461 | -26,621 |
| **Haifa** | 19,436 | 21,883 | 22,586 | 28,094 | 28,707 | 26,140 | 25,055 | 21,747 | 21,252 | 23,181 | 14,499 | 16,053 | 24,455 | 22,910 |
| **Hadera** | -7,179 | -9,828 | -10,613 | -11,084 | -11,477 | -9,403 | -14,754 | -18,036 | -18,821 | -18,916 | -18,269 | -14,980 | -19,575 | -18,599 |
| **Sharon** | -16,213 | -14,887 | -15,270 | -17,656 | -17,053 | -19,056 | -22,045 | -18,961 | -16,299 | -21,398 | -15,321 | -12,221 | -13,815 | -19,386 |
| **Petah Tiqwa** | -29,519 | -28,753 | -30,721 | -34,457 | -36,107 | -31,127 | -28,441 | -28,223 | -23,182 | -22,187 | -21,776 | -20,184 | -21,048 | -16,953 |
| **Ramla** | 15,655 | 15,427 | 15,374 | 12,858 | 13,629 | 15,830 | 14,939 | 4,353 | 5,289 | 3,358 | 8,509 | 3,676 | 8,351 | 10,220 |
| **Rehovot** | -25,873 | -25,628 | -24,475 | -26,624 | -28,256 | -29,178 | -27,744 | -30,620 | -38,876 | -35,285 | -33,216 | -32,111 | -38,019 | -39,909 |
| **Tel Aviv** | 138,707 | 144,865 | 150,645 | 160,501 | 163,794 | 161,148 | 163,296 | 172,249 | 171,276 | 177,281 | 170,299 | 161,229 | 171,544 | 169,298 |
| **Ramat Gan** | -20,912 | -15,815 | -14,866 | -11,554 | -8,238 | -11,773 | -8,596 | -7,939 | -7,635 | -11,017 | -7,477 | -4,394 | -2,576 | -3,178 |
| **Holon** | -49,048 | -53,822 | -56,604 | -56,177 | -54,727 | -50,798 | -53,453 | -50,676 | -52,985 | -53,077 | -53,701 | -46,635 | -50,402 | -50,135 |
| **Ashqelon** | -423 | -2,119 | -2,748 | -7,227 | -11,993 | -13,545 | -13,070 | -10,534 | -9,446 | -8,963 | -15,186 | -16,334 | -13,443 | -14,692 |
| **Be'er Sheva** | 1,162 | 852 | 474 | -139 | 1,909 | 1,646 | -2,200 | -2,884 | -2,325 | -1,422 | -2,543 | -732 | 498 | -762 |
| **Judea and Samaria** | -14,040 | -13,728 | -16,422 | -18,901 | -18,087 | -20,025 | -19,940 | -22,365 | -23,810 | -30,207 | -31,513 | -31,675 | -32,386 | -32,721 |

*Source: Calculations of Labor Force Surveys, various years, CBS*

The numbers reported in Tables 2-3 demonstrate that commuting flows between sub-districts are not even and are mostly concentrated in the geographic center of the economy. Sub-districts characterized by high commuting activity (in both directions) are Tel Aviv, Ramat Gan, Holon, Petah-Tiqwa, Ramla and Rehovot. Out-commuting rates in these sub-districts range from 20-25 percent in the Tel Aviv sub-district to more than 60 percent in the Holon sub-district, and in-commuting rates range from 25-30 percent in the Rehovot sub-district to almost 50 percent in the Tel Aviv sub-district. In the rest of the regions commuting activity is much weaker. Thus no more than 6, 8 and 5 percent of the employed residents in the Jerusalem, Zefat and Kinneret and Be'er Sheva sub-districts respectively, were employed outside their residential sub-district. It is reasonable to assume that since the extent of self-sufficiency increases with the size of the region and with the distance from the center, these regions may be considered to be independent labor markets. On the other hand, small and centrally located sub-districts are in no sense self-sufficient.

The data allows us to follow changes in the commuting patterns of different regions. Out-commuting rates rose during the period under investigation in the Haifa, Hadera, Ramla, Tel Aviv, and Ashqelon sub-districts, but remained stable in the Jerusalem, Zefat and Kinneret, Akko, Sharon, Petah Tiqwa, Rehovot, Ramat Gan, Holon and Be'er Sheva sub-districts. The stability of commuting rates in the second group of regions is also reflected by low standard deviations. Interestingly, in no single sub-district did the out-commuting rate fall during the period. In-commuting rates rose slowly in the Zefat and Kinneret, Hadera and Tel Aviv sub-districts and more rapidly in the Jerusalem, Sharon, Petah Tiqwa, Rehovot, Ramat Gan, Holon and Judea and Samaria sub-districts, and fell in the Ramla sub-district. In the Akko, Haifa, Ashqelon and Be'er Sheva sub-districts in-commuting rates were so unstable that it was not possible to distinguish a clear trend.

Analysis of both in- and out-commuting rates (figure 1) indicates that the Tel Aviv sub-district is the only one that is prominently employment-oriented. On the other hand, the Judea and Samaria sub-district and, to lesser extent, the Holon sub-district are prominently residence-oriented. Relatively low both in- and out-commuting rates in the Be'er Sheva, Jerusalem and Zefat and Kinneret sub-districts indicate their relatively high economic autonomy.

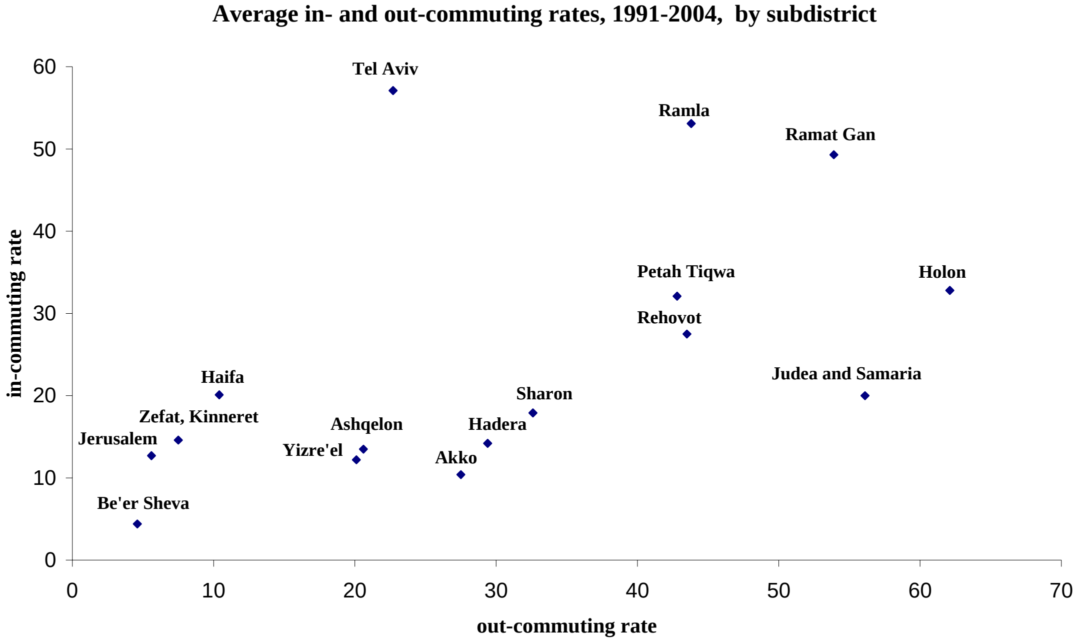


*Figure 1*

Only five sub-districts had positive commuting balances throughout the entire period: Jerusalem, Zefat and Kinneret, Haifa, Ramla and Tel Aviv. The greatest job provider is the Tel Aviv sub-district, in spite of its relatively modest geographical dimensions. The number of commuters employed within the Tel Aviv sub-district rose from approximately 140,000 in 1991 to more than 170,000 in 1998, among whom the number of in-commuters who are not Tel Aviv district[6] residents rose from approximately 70,000 in the beginning of the period to more than 110,000 in 1998 and thereafter. Within the central district[7] only the Ramla sub-district had a positive commuting balance. Its in-commuting flows fell sharply from over 15,000 in 1991-1993 to only a few thousand in 1998 and thereafter, but started to recover in 2003-2004. Two additional sub-districts which provided a surplus of workplaces are Jerusalem (commuting balance grew by 3.5 times during the period and reached over 28,000 employees in 2004) and Haifa with a commuting balance of more than 20,000 employees in most of the period except for a temporary slump in 2001-2002. The majority of in-commuters in the Jerusalem sub-district arrive from Judea and Samaria

[6] Israel is divided into 7 districts - Jerusalem, Northern, Haifa, Central, Tel Aviv, Southern and Judea and Samaria, most of which are divided into smaller sub-districts. For example, the Tel Aviv district consists of the Tel Aviv, Ramat Gan and Holon sub-districts.
[7] Central district includes the Sharon, Petah Tiqwa, Ramla and Rehovot sub-districts.

and in the Haifa sub-district from the Northern district[8], especially the Akko sub-district. The fifth sub-district with a positive commuting balance is Zefat and Kinneret, which provides jobs for the Yizre'el and Akko sub-districts residents. The sub-districts with substantial negative commuting balances are Holon (over 50,000 net out-commuters per year), Judea and Samaria (the net number of out-commuters more than doubled since 1991, and over half of the working population was employed outside the sub-district), Petah Tiqwa (with approximately 30,000 out-commuters in 1991-1998, followed by a sharp, continuous decrease after 1998), Rehovot (where the negative balance rose from 25,000 to almost 40,000 employed people), and Akko (with 20,000-30,000 net out-commuters per year). The negative commuting balance of the Ramat Gan sub-district decreased sharply from 20,000 per year to only a few thousand. Conversely, the number of Ashqelon residents employed outside the residential sub-district increased sharply from less than 1,000 in 1991 to over 15,000 at the end of the period, possibly due to the dramatic population increase following massive immigration from the former Soviet Union in the beginning of the 1990's. Among the most attractive residential features of the Ashqelon sub-district are proximity to the sea, relatively low housing prices and a comfortable living environment, especially compared to the crowded Tel Aviv and Central districts. The Ashqelon region is very close to the center and has the highest unemployment rate in the economy, so its residents tend to seek employment opportunities outside the region.

Similar to other countries, in Israel, commuting rates are higher among younger and more highly educated employees, and men tend to commute more than women. Table 5 summarizes the main features of Israeli commuters and reports the proportion of commuters in all gender, education and age groups. The rate of commuting between sub-districts rose during the period under investigation in both gender groups. On average, 31 percent of employed males and 22.4 percent of employed females commuted between sub-districts. The proportion of those employed outside the sub-district of residence monotonically increases with educational level, from an average of 22.3 percent among those who reported 0-8 years of schooling to 31.9 percent, on average, amongst highly educated employees (16+ years of schooling). Throughout

[8] Northern district consists of the Zefat and Kinneret, Yizre'el and Akko sub-districts and also the Golan sub-district which is too small to be included in the research.

the period, commuting rates of most employees with secondary school educations (9-10 and 11-12 years of schooling) were stable, while those of employees with higher educations rose. Thus during the period 1991-2004 commuting rates among those who reported 13-15 and 16+ years of schooling rose by approximately 20 and 10 percent, respectively. As can be expected, when categorized by age, the 25-34 age group is the most mobile. In this group the rate of those employed outside the residential sub-district is 29.5 on average, increasing from 26.7 percent in 1991 to over 31 percent in later years. Individuals aged 35-54 were almost identically mobile regarding employment and their commuting rates rose during the period. Older employees commute less, but even those aged 55+ required to commute more with time. Even so, we can't claim that commuting activity of the *same* individuals falls after age 35. When following cohorts' behavior it can be seen that the age-commuting relationship is likely to have an inverted U shape. As Table 6 shows, commuting rates of the same age cohorts rise at age 25-34, remain relatively stable up to age 45-54 and start to fall after then, slowly at age 55-64 and faster at age 65+.

Unfortunately the data collection technique adopted by the Israeli CBS does not allow comparison between the wage rates of commuters and non-commuters. Wage data appear in Income Surveys only, which do not report locality of workplace, while commuting data is reported in Labor Force Surveys, which do not include wage data.

*Table 5 – Rate of commuting between sub-districts; breakdown by gender, education and age (as percentage of total group population)*

| | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | Average 1991-2004 | Std 1991-2004 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Gender:** | | | | | | | | | | | | | | | | |
| male | 28.8 | 29.2 | 30.5 | 29.7 | 30.9 | 31.3 | 30.7 | 30.7 | 31.9 | 32.3 | 32.5 | 32.1 | 32.3 | 31.6 | **31.0** | **1.2** |
| female | 19.9 | 20.5 | 20.7 | 20.8 | 21.6 | 21.9 | 21.9 | 22.5 | 23.1 | 24.3 | 23.9 | 23.4 | 24.0 | 24.4 | **22.4** | **1.5** |
| **Schooling:** | | | | | | | | | | | | | | | | |
| 0-8 years | 21.9 | 22.8 | 22.5 | 22.3 | 23.9 | 24.2 | 23.4 | 21.2 | 22.4 | 22.1 | 20.2 | 21.6 | 21.8 | 21.2 | **22.3** | **1.1** |
| 9-10 years | 23.8 | 23.2 | 25.5 | 24.7 | 26.1 | 25.0 | 24.0 | 23.4 | 23.2 | 23.4 | 22.9 | 23.5 | 23.9 | 23.7 | **24.0** | **1.0** |
| 11-12 years | 25.3 | 25.2 | 25.4 | 25.4 | 26.2 | 26.2 | 25.8 | 26.1 | 26.4 | 26.9 | 27.0 | 25.2 | 26.4 | 26.0 | **26.0** | **0.6** |
| 13-15 years | 25.1 | 26.4 | 25.7 | 26.3 | 26.5 | 28.1 | 27.2 | 27.3 | 29.1 | 30.1 | 30.0 | 29.7 | 29.3 | 29.2 | **28.0** | **1.6** |
| 16+ years | 30.3 | 30.7 | 31.2 | 30.5 | 31.0 | 30.8 | 31.4 | 31.8 | 32.7 | 33.3 | 33.3 | 33.6 | 33.3 | 32.9 | **31.9** | **1.2** |
| **Age:** | | | | | | | | | | | | | | | | |
| 15-24 | 23.8 | 24.1 | 24.8 | 26.4 | 26.2 | 26.0 | 26.7 | 25.8 | 25.7 | 27.6 | 27.7 | 25.7 | 25.9 | 25.6 | **25.9** | **1.1** |
| 25-34 | 26.7 | 26.7 | 27.6 | 26.8 | 29.3 | 29.4 | 28.5 | 29.7 | 31.1 | 31.9 | 31.1 | 30.8 | 32.1 | 31.5 | **29.5** | **2.0** |
| 35-44 | 26.3 | 26.8 | 27.7 | 26.7 | 26.9 | 27.7 | 26.9 | 27.1 | 27.5 | 27.7 | 28.5 | 28.5 | 28.6 | 28.7 | **27.6** | **0.8** |
| 45-54 | 24.9 | 26.1 | 26.8 | 26.3 | 27.4 | 27.1 | 27.3 | 27.2 | 27.6 | 28.1 | 28.3 | 27.4 | 27.1 | 26.9 | **27.0** | **0.8** |
| 55-64 | 23.0 | 23.8 | 24.1 | 23.0 | 23.9 | 24.1 | 24.3 | 23.2 | 25.9 | 26.0 | 25.5 | 26.0 | 26.0 | 26.2 | **24.6** | **1.2** |
| 65+ | 18.2 | 17.5 | 17.1 | 17.8 | 15.9 | 19.5 | 17.5 | 18.0 | 20.8 | 22.5 | 19.7 | 21.4 | 20.0 | 21.4 | **19.1** | **1.9** |

*Source: Calculations of Labor Force Surveys, various years, CBS*

*Table 6 – Commuting rates by age cohorts*

| Age cohort | 1991 | 1992 | 1993 | 1994 | | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|---|---|---|
| 15-24 in 1991<br>25-34 in 2001 | 23.8 | 24.1 | 24.8 | 26.4 | | 31.1 | 30.8 | 32.1 | 31.5 |
| 25-34 in 1991<br>35-44 in 2001 | 26.7 | 26.7 | 27.6 | 26.8 | | 28.5 | 28.5 | 28.6 | 28.7 |
| 35-44 in 1991<br>45-54 in 2001 | 26.3 | 26.8 | 27.7 | 26.7 | | 28.3 | 27.4 | 27.1 | 26.9 |
| 45-54 in 1991<br>54-64 in 2001 | 24.9 | 26.1 | 26.8 | 26.3 | | 25.5 | 26.0 | 26.0 | 26.2 |
| 55-64 in 1991<br>64+ in 2001 | 23.0 | 23.8 | 24.1 | 23.0 | | 19.7 | 21.4 | 20.0 | 21.4 |

## 6. Previous research on commuting in Israel

Research on commuting in Israel is mostly organized as case studies which examine commuting patterns in certain regions. Although commuting has become a wide-spread Israeli labor market phenomenon, no systematic study has been undertaken in this field. The most comprehensive study on commuting was conducted by Felsenstein and Shachar (1994) who examined inter-district commuting from 1980-1990. Their study concluded that the Tel Aviv district was the only employment-oriented region throughout the entire period; the Haifa district moved from zero net commuting to employment-oriented, and the other districts (Jerusalem, Northern, Central and Southern districts) were residential-oriented.

Studies in the 1980's and the 1990's demonstrated that commuting patterns of Israeli employees were very similar to those found in other countries. The survey conducted among 1,200 employees in the Haifa metropolitan area pointed out that highly educated middle income workers employed in the advanced services were more likely to commute (Kipnis and Mansfeld, 1986). Another study suggested that many employees who walk to their workplaces are relatively poorly educated and paid, and only a small proportion of them are home owners (Plaut, 2004). A study of commuting behavior in the Tel Aviv metropolitan area based on 1983 Population Census showed that employees in skilled occupations often commute longer distances. However a substantial proportion of unskilled workers also commute, while some skilled employees commute rather short distances (Blumen, 1998). Another study that examined changes in commuting patterns of women in the Haifa metropolitan area from 1972-1983 noted that commuting distances lengthened throughout the period; although, on average, women in the Haifa metropolitan area commuted shorter distances than did women in other districts (Blumen and Kellerman, 1990). The authors attributed the relatively short commutes in Haifa metropolitan to its geography—a lack of wide-spread suburbs—and to women's low labor force participation and low auto ownership rates. A survey conducted among mothers employed full-time showed that women developed positive attitudes towards commuting, viewing a daily trip as an opportunity for diversion and relief (Blumen, 2000). Pazy et al. (1996) conducted a survey among female university graduates employed in the computer field and found that more career-oriented women were willing to commute longer distances in exchange for professional promotion. At the same time, mothers of young children and women who had to use public transport for commuting expressed a strong unwillingness to increase their travel time.

Commuting patterns of those employed in human capital intensive industries were examined in three detailed papers concerning the technologically intensive industrial zones in Rehovot-Nes Ziona (Vider and Shepfer, 1993), Haifa (Shtainmitz, 1989) and in the Ramla-Lod region and Haifa Technological Industries Campus (Felsenstein, 1994). The first study showed that firms often attract unskilled workers from distances even greater than those traveled by skilled workers. The second study found that firms operating in advanced industries in Haifa attract approximately 16 percent of academic professionals working in administrative occupations and close to 8 percent of their engineers from the Tel Aviv metropolitan area. The third study found substantial differences in commuting patterns in the Haifa and Ramla-Lod industrial centers. Regarding Haifa, most of the workers live within a radius of 30 kilometers, though there are some who reside in the Tel Aviv metropolitan area, travelling more than 60 kilometers (in each direction) in order to work in Haifa. Those who commute from Tel Aviv are highly skilled and educated, i.e. commuting distance rises with educational level. The local labor market for the Ramla-Lod employment center sprawls for more than 30 kilometers in all directions but, as opposed to findings in Haifa area, in the Ramla-Lod industrial center the labor market for skilled workers is nested within the labor market for the less skilled workers, mainly due to the lack of suitable local supply of semi-skilled workers.

The reliance on highly skilled workers encouraged technological firms to develop organized transportation systems for employees who commute long distances. As a result, establishments whose local labor markets sprawl over distances of more than 30 kilometers provide transportation for less skilled workers, although the expected return from these workers is relatively low (Felsenstein, 1992).

In Israel, company-financed transportation developed historically as a result of several economy-specific factors. First, due to the existing state-subsidized mortgage system the proportion of home owners is relatively high; along with a widespread public rental sector, home ownership restricted the mobility of the labor force (Felsenstein, 1994). Second, the Israeli taxation system recognizes transportation costs in a non-symmetric manner; while a firm can deduct these costs from its profits, an employee has to carry the entire financial burden. Third, the proportion of private vehicle ownership is relatively low (most households possess only one car) due to high purchase and maintenance costs. Fourth, and finally, most large industrial establishments are located in special industrial zones which are not accessible by public transportation, so many firms are forced to provide transportation for unskilled employees (Felsenstein, 1994).

## 7. Gravity model and variables definition

The empirical analysis employed in this paper is based on a gravity model widely used in migration analysis (Greenwood, 1997, Helliwell, 1997, Andrienko and Guriev, 2003) and in international trade studies. Actually, the gravity model used in economics imitates Newton's law of gravitation in physics. The number of commuters, $C_{ij}$, who are attracted to region $j$ (destination) from region $i$ (origin) increases with the size of population in both regions ($P_i$, $P_j$) and decreases with the distance between the two regions, $D_{ij}$:

$$C_{ij} = G \cdot \frac{P_i^{\alpha} \cdot P_j^{\beta}}{D_{ij}^{\gamma}}, \qquad (1)$$

where $G$ is a constant depending on the characteristics of regions $i$ and $j$, and $\alpha, \beta, \gamma$ are the estimated parameters. While physical law assumes that $\alpha = 1, \beta = 1, \gamma = 2$, these parameters may be different when estimating an economic model of commuting or migration. The distance between regions of origin and destination influences commuting decisions based upon existing transportation, job search and psychological costs. Since those costs increase with distance, it is reasonable to expect a positive parameter $\gamma > 0$. Of course a physical model alone can't explain the economic phenomenon of commuting. Since regions differ in their economic development and in living and social conditions, a simple gravity model must be extended to incorporate various characteristics of origin and destination regions.

Intuitively an individual chooses to commute because, on the one hand, she finds labor market conditions in the destination region more attractive than in the residential region and, on the other hand, she prefers the environmental properties of the residential region above those in the employment region. So, explanatory variables should express those features of districts of origin which make them attractive as residential areas, and those of labor markets in destination regions which attract employment.

A simple urban model assumes that choosing one’s residential and employment location depends upon relative wage level (which influences the choice of employment location), relative housing prices (influencing residential choice) in both origin and destination regions, and distance between residential and employment locations (which influences both decisions). The empirical model has to account for additional factors such as living conditions, traffic density, regional economic structure and labor market quality.

Alonso's model suggests two quality of life variables which may be used: housing prices and area. Regions providing more employment opportunities are more densely populated and the land more heavily used for industrial, trade and business purposes. As a result, there is less land for home construction and housing prices are relatively high. But the main problem of conducting research on commuting in Israel is the lack of housing price data on the sub-district level. Nevertheless we can expect a strong correlation between housing prices and housing density. Since centrally located regions are characterized by a lack of land for residential construction, Alonso's model predicts that housing size will decrease as the distance to the employment center decreases. On the other hand, as distances from the center increase, building becomes cheaper and homes more spacious. So we expect to see increases in both price and density within centrally located regions.

As home ownership becomes more wide-spread, the influence of relative housing prices strengthens and people are more reluctant to migrate. In Israel, there is no data on the proportion of home ownership by sub-district. As far as the whole economy is concerned, approximately 70 percent of households reside in self-owned apartments, and this proportion has not changed since the second half of the 1980's (according to Expenditure Surveys conducted by the Israeli CBS).

Migration and commuting studies usually consider various additional living conditions which tend to influence residential decisions such as climate, cultural level, crime rate or urban structure. Thus the econometric model must include a significant number of explanatory variables, thereby reducing the number of degrees of freedom and causing the multicollinearity problem, due to the high correlation between these variables. Another problem is that including only one or two variables can cause a loss of information. Thus the best solution is to employ a regional weighted quality of life index. But due to small spatial dimensions of Israeli economy, such an index is not calculated for Israel.

The vector of labor market variables should include wage rate and unemployment rate. In accordance with theoretical models we expect that commuting flows would be directed to regions with lower unemployment. To overcome possible simultaneity in determining unemployment and commuting rates it is worthwhile to use long term regional averages instead of contemporaneous unemployment rates.

Working age population or labor force size can influence the prospect of finding employment in a region. A region’s employment abundance can be measured by the ratio of total employed to its labor force. This ratio is expected to change substantially within the regions – higher in central regions and lower in the peripheral ones. In general, employment-rich regions attract commuters from employment-poor regions. As the number of available jobs in a region increases, the workers are able to find more suitable employment possibilities near their homes. In the Netherlands, Schwanen et al. (2004) found that in regions with a higher job-to-residential labor force ratio individuals tend to commute less. But if the number of jobs is relatively scarce, residents find it difficult to find a job near home (Levinson, 1998).

Regional differences in the characteristics of the working age population should influence commuting patterns of the region's residents. For example, the total out-commuting rate is likely to decrease as the proportion of households with young children or the share of elderly population increases. Commuting decisions also depend upon educational levels. Romani et al. (2002) propose that the occupational or sectoral composition of the labor force should not influence aggregate commuting flows, although they are important for commuting decisions at the individual level.

Better infrastructure and public transportation and shorter inter-regional distances cause more active commuting flows. The optimal measure is commuting time, but it is not feasible for computation in an aggregate study. The vector of accessibility variables for each pair of regions may include the distance between them and a dummy variable for a common border, receiving a value of 1 if two regions are neighboring and 0 otherwise[9].

The gravity model is usually estimated in logarithmic form and can be presented as:

$$\ln C_{ijt} = c + \alpha \ln P_{it} + \beta \ln P_{jt} + \gamma \ln D_{ij} + \lambda'\left(Y_{jt}/Y_{it}\right) + \mu' T_{ij} + \eta_{ij} + \delta_t + \xi_{ijt}, \qquad (2)$$

where $P_{it}$ and $P_{jt}$ are working-age population size in regions $i$ and $j$, respectively, in year $t$, $Y_{it}$ and $Y_{jt}$ are vectors of time-varying characteristics of origin and destination regions, including housing and labor market features and labor force characteristics, and $T_{ij}$ is a vector of variables expressing accessibility measures between each pair of regions. Fixed commuting-routes effects $\eta_{ij}$ may control for unique non-varying regional characteristics. In panel data estimation inclusion of $\eta_{ij}$ is identical to fixed effects estimation (see further discussion). Year dummies, $\delta_t$, capture macroeconomic shocks common to all regions and some factors which uniformly influenced all

[9] Merriman and Hellerstein (1994) and Crampton (1990) stressed the importance of railway connections between regions for commuting. Romani et al. (2002) added a dummy variable for railway connections between pairs of regions, but the estimated coefficient was statistically insignificant.

regions in year *t*. Commuting flows may change throughout the period, due to creation and destruction of jobs, widening residential areas and infrastructure developments. These changes are also captured by year dummies. Table 7 lists all variables defined for the study:

*Table 7 Llist of variables, their definition and calculation method*

| Variable | Definition and calculation |
|---|---|
| $\ln C_{ij}$ | commuters - dependent variable - log number of commuters from region *i* to region *j* |
| $\ln P_i$ | log working age population, origin |
| $\ln P_j$ | log working age population, destination |
| $\ln D_{ij}$ | distance - log distance between sub-districts (for details see Appendix A) |
| *border* | common border - binary variable: 1 if two regions adjacent, 0 otherwise |
| *hous_dens* | housing density - average number of household members per room[10], destination divided by origin |
| *children* | average number of children age 0-4 per household, destination divided by origin |
| *mobile* | the most mobile population - proportion of males age 25-34 with 13+ years of schooling in labor force, destination divided by origin |
| *U* | unemployment rate - moving average of regional unemployment rate during 10 years prior to year *t*, destination divided by origin |
| *E/LF* | employment density - number of employed in the region divided by residential labor force, destination divided by origin |
| *wagemix*[11] | weighted wage index, destination divided by origin, in constant year 2000 prices. For all regions and years this is calculated as $\sum S_{ik} \cdot W_{Lk}$ , when $S_{ik}$ is proportion of sector *k* in total employment of region *i* and $W_{Lk}$ is average earnings in sector *k* at the economy-wide level, calculated for 14 main sectors (for details see Appendix B) |

Inter-regional distances were measured as the shortest driving routes between the administrative centers of the sub-districts, in kilometers. In relatively large regions

[10] We realize that this method of calculation is not optimal because an important indicator is *the size of the dwelling* and not *the number of rooms*. For example, a two-bedroom dwelling can be either sixty or one hundred square meters, but this difference is not captured by the persons-per-room calculation. Since there is no regional data on average housing size, the proxy which was calculated may be inadequate.

[11] The index was introduced by Partridge and Rickman (1997).

two to three central towns were chosen and average distances between all centers were calculated (see Appendix A). Such a calculation method necessarily hides measurement errors because the distances are calculated relative to sub-districts' centers, while employment centers and residential neighborhoods are spread more evenly within the regions. Thus measured distances are likely to be quite different from individual real commuting distances. In general, distribution of measurement errors depends upon residential patterns and firms' location within the region, road infrastructure and public transportation routes. For the sake of estimation we assume that these measurement errors are randomly distributed.

A more detailed description of the data is in Appendix B. Data on housing density, number of children in the household, proportion of the most mobile labor force, unemployment rate, employment density and wage index averages for all sub-districts are reported in Table B1 (Appendix B).

For the purposes of real wage comparison, all wage levels were calculated according to constant 2000 prices. The wage index weighted by regional economic sector shares in employment (number of employed in each economic sector divided by total regional employment) is not a "real" wage paid to employees in the region. The absence of job locality information in the Income Surveys prevents useful wage comparison in different regions. As a result there is very limited variation in regional wage levels[12]. Moreover, the lack of data on regional price levels prevents the use of wage rates adjusted to local prices.

Since there are zero cells in the dependent variable (pairs of sub-districts without commuting flows between them) which is expressed in the logarithmic form, we have to substitute a non-zero value to keep finite log values. The total is 240 observations each year (for 16 regions). The number of zero cells ranges from 9 (3.8% of observations) in 2000 to 35 (14.6% of observations) in 1992-93. In the whole 14-year panel, there are 310 zero cells which constitute 9.2% of the sample. For estimation we substitute zeros for 0.5, as suggested by Andrienko and Guriev (2003).

[12] For example, in 1991 the average hourly wage ranged from NIS 29.0 in the Zefat and Kinneret sub-district to NIS 31.7 in Judea and Samaria, and in 2004 – from NIS 36.7 to NIS 39.3, in the same regions, respectively.

## 8. Estimation and results

The model was first estimated by pooled OLS with a set of year dummies to capture possible changes within time and economy-wide trends common to all regions, but without fixed commuting routes effects, $\eta_{ij}$. In the simple OLS estimation the Breusch-Pagan test detected some form of heteroskedasticity which, we assume, is caused by the differences in unobserved error variances between the regional units. So the model was estimated with robust standard errors clustered by commuting routes[13]. The results are reported in the first column of Table 8. But non-inclusion of region-specific fixed effects is likely to cause omitted variable bias in the OLS estimates.

Since database built for estimation is organized as a real panel (the same observation units – 240 intra-sub-districts commuting routes – throughout 14 years), we can exploit the nature of the data and perform the estimation by the fixed effects technique, which controls for fixed commuting routes effects, while the estimation is based on the assumption that fixed regional characteristics correlate with other explanatory variables. The results are reported in the second column of Table 8. Although fixed effects estimation provides consistent and unbiased estimators (nevertheless, they are not efficient), in this particular case it has two potentially important drawbacks. Firstly, in the fixed effects estimation, all variables that do not change with time (e.g. inter-regional distances and common border control) are automatically discarded. As we assume that these variables are highly influential and since one of the objectives of this paper is to evaluate their influence on commuting flows, we have to employ alternative estimation techniques. Secondly, the variation within each region-specific group of time-varying variables ($Y_i$, $Y_j$) is very low in our relatively short sample. As a result, a within $R^2$ is extremely low (0.094).

An alternative estimation method for panel data is the random effects estimation. The results are displayed in the third column of Table 8. The overall $R^2$ is comparable with the OLS R-squared. The main shortcoming of random effects technique is a strong assumption of no correlation between the individual regional effects and other explanatory variables that often does not seem reasonable in regional data. The price of using random effects method when this assumption does not hold may be rather

[13] All other models that are discussed further were estimated by the same method of clustering.

high: the estimators are inconsistent. To determine if this is the case and to choose between fixed and random effects methods we perform Hausman's specification test. Using the current specification, our hypothesis that individual-level commuting routes effects are adequately modeled by a random-effects model can't be rejected (Hausman's statistic is $\chi^2(21)=13.79$ with Prob=0.8784, so the differences between fixed-effects and random-effects estimators are not systematic). It is important to mention that random-effects estimators are not only consistent, but also more efficient than fixed-effects estimators. In the further discussion we will refer to the random-effects estimation results.

*Table 8 –Estimation results*

| Variable | OLS with clustered robust std errors | FE with clustered robust std errors | RE with clustered robust std errors |
|---|---|---|---|
| **ln $P_i$ (origin)** | 0.910* (4.29) | 1.468* (3.46) | 0.972* (4.64) |
| **ln $P_j$ (destination)** | 0.817* (4.77) | 1.646* (3.54) | 1.044* (5.68) |
| **ln $D_{ij}$** | -1.627* (12.58) | | -1.579* (11.67) |
| ***border*** | 1.140* (6.19) | | 1.220* (6.47) |
| ***hous_dens*** | -1.359** (2.13) | 2.310** (2.22) | 0.237 (0.36) |
| ***children*** | 0.053 (0.23) | -0.103 (0.37) | -0.086 (0.39) |
| ***mobile*** | -0.150 (0.83) | -0.205 (1.43) | -0.219 (1.52) |
| ***U*** | 0.296 (1.03) | 0.340 (0.70) | 0.057 (0.22) |
| ***E/LF*** | 0.763* (3.07) | 0.909** (2.45) | 0.877* (4.64) |
| ***wagemix*** | 8.325* (3.87) | 2.257 (1.08) | 4.811* (2.83) |
| ***year dummies*** | yes | yes | yes |
| ***$R^2$*** | **0.540** | **0.094**[14] | **0.531**[15] |

*Notes: t-statistics in parentheses*

**    coefficient is significant at 1% significance level*

***    coefficient is significant at 5% significance level*

The results point out that the pushing power of the origin sub-district is similar to the attraction power of the destination sub-district (quantitatively, the coefficients are very close to one, as in Newton's law of gravitation) and the influence of working-age

[14] within $R^2$.
[15] overall $R^2$.

population size is statistically highly significant. As was expected, the greater the distance between regions the weaker the commuting flow. Since both the number of commuters and distance are in logarithmic form, the estimated coefficient is elasticity of commuting flow with respect to distance. Keeping other factors fixed, increasing the distance between two sub-districts by 10 percent is expected to decrease the commuting flow by almost 16 percent (with a very high t-statistic of 11.67). Common border control is also statistically significant at 1% level. Commuting flows are almost 3.4 times larger between two neighboring sub-districts, other things being equal. Consistent with theory, distance and common border influences reinforce each other.

The influence of housing density and proportion of males age 25-34 with 13+ years of schooling in the labor force in the sub-district of origin relative to the sub-district of destination is not statistically significant, but the coefficients have the signs consistent with theory. As far as the housing density variable is concerned, its statistical insignificance may be caused by the nature of the data that was used for empirical investigation. As was mentioned earlier (see footnote 10), the variable was calculated as an average number of household members per room in a dwelling and there is no substantial variation between regions.

In contrast to our expectations, out-commuting flows decrease as the average number of children per household ratio between destination and origin regions decreases. In other words, on average, employees in households with fewer children under five years old tend to commute less, but the influence of number of children ratio is statistically insignificant.

An additional result that contradicts the theoretical model is the positive (but statistically insignificant and close to zero) coefficient of the unemployment rate ratio. A positive estimate means that commuting flows are directed from regions with relatively low unemployment rates to regions with relatively high joblessness. This surprising result can by no means be explained by possible simultaneity in determining the unemployment and commuting rates, since the unemployment rate was calculated as a moving average for the period of ten years prior to the year of commuting data. Nevertheless these empirical results are less surprising when analyzing raw commuting data. For example, many workers residing in the northern sub-districts are employed in the Haifa sub-district in spite of its substantially higher unemployment rate. Similarly, many employees commute from Judea and Samaria to the Jerusalem sub-district, although the unemployment rate is much lower in Judea and Samaria. The commuting balance of the Ramla sub-district is positive though it is characterized by one of the highest unemployment rates in the economy. The data and the estimation results constitute background for the hypothesis that commuting patterns were determined decades before the investigated period and in the past had already influenced the formation of the regional unemployment rates system. It can be speculated further that all causal relationship between commuting and unemployment was twisted when commuters "occupied" jobs and local residents were left behind. One objective reason for such behavior can be a mismatch between the quality of "desired" and "existent" human capital. Checking this hypothesis requires a detailed comparison of commuter and unemployed labor force characteristics, which is beyond the scope of this paper.

As predicted by theoretical models, two important factors attracting commuters are employment density, used as a proxy for regional labor demand, and the wage rate. An increase in the employment-density destination-to-origin ratio by 0.1 is associated with an increase of 9.2% in the number of commuters, other things being equal. According to the *wagemix* coefficient, an increase of 0.1 in the wage index destination-to-origin ratio strengthens the commuting flow by 62%, *ceteris paribus*. Nevertheless, we ought to be careful in the interpretation: as was mentioned, the *wagemix* variable is a rather hypothetical wage measure and not the real wage rate.

Almost all year dummies are positive (in accordance with the raw data which demonstrated increasing commuting trends), but only partly significant statistically, meaning that commuting patterns were fairly stable throughout the whole period.

To check the robustness of the distance and common border influence we also estimated a dummy variables least squares model (DVLS). To incorporate the qualitative differences between commuting routes (road quality, extent of driving difficulty and traffic congestion) we allow for different marginal influences of the distance on the commuting flow by defining the interactions between commuting routes and distance ($D_{ij} * \eta_{ij}$). So, the distance coefficient, γ, captures only that portion of influence that is common for all commuting routes. In the dummy variables estimation, all coefficients are identical to FE estimation, the coefficient of the distance variable equals -1.33 with a t-statistics of 5.60, and the common border influence becomes statistically insignificant.

## 9. Conclusions

This paper presents a first comprehensive attempt to investigate and quantify inter-sub-district commuting patterns in Israel. Commuting is a wide-spread phenomenon in the Israeli labor market, and this description of commuting paths indicates that there are five sub-districts with consistently positive commuting balance and three sub-districts that can be considered as self-sufficient. In general, individual commuting patterns documented in Israel are very similar to those found in other countries. Empirical examination of inter-sub-districts commuting flows illustrates that commuting behavior is mainly motivated by geographical proximity, relative ease of finding a job and potential wage level. It must be noted that data limitations harm the reliability of the results, while the main distortion may originate from the lack of regional price levels and wage data regarding the sub-district of employment. Nonetheless, the study produces challenges for additional examinations of issues related to commuting, such as the functional rather than administrative division of the economy to local labor markets based on a regional employment sufficiency definition and extending the research on reciprocal relationship between commuting and unemployment.

Concerning possible policy implications, the most important conclusion is that commuting behavior mainly characterizes highly educated employees and commuting flows decrease with distance. Therefore government that sees its objective in reducing the unemployment rate among the most disadvantaged groups in the labor force can't rely on the possible ability of commuting to narrow regional gaps in the unemployment rates. Commuting does not represent an appropriate solution for the employment of poorly educated and relatively old peripheral residents, especially the inhabitants of development towns in the south and in the north. Effective treatment of their unemployment problem requires a direct intervention, such as increasing incentives for establishing employment centers in the peripheral regions of the economy with appropriate range of employment opportunities for a relatively low-skilled labor force, or improving the public transportation system to ease the access to the existing ones.

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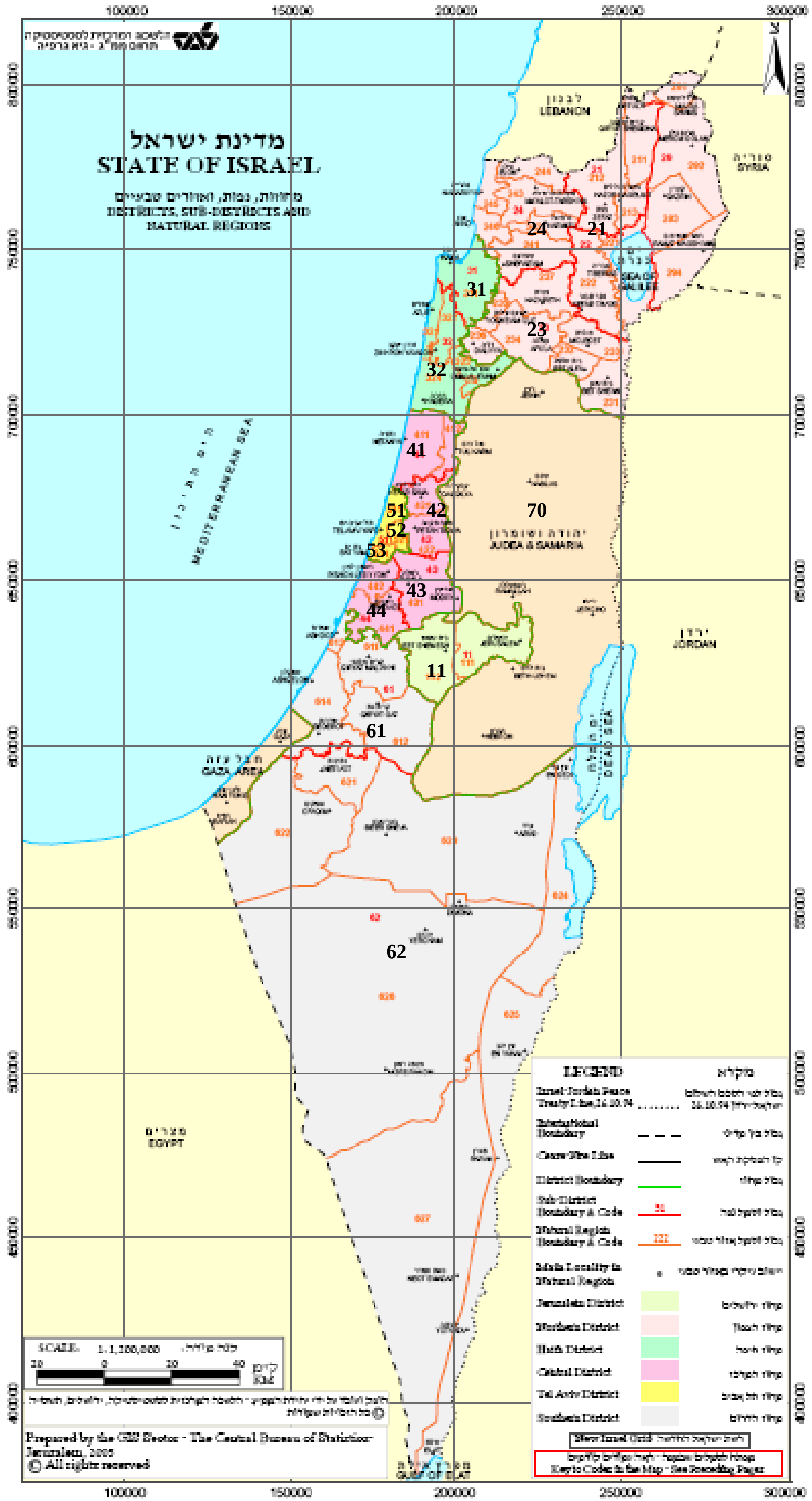
## Appendix A – Sub-districts and inter-regional distances calculation



The distances between the sub-districts were calculated as the distances between their geographical centers, in kilometers. The distances were measured as the shortest driving routes between the sub-districts' administrative centers. In the relatively large sub-districts and in the sub-districts where administrative centers are not the geographical center of the region, two or three main towns were chosen and the distances were calculated as averages of the distances between all centers.

| **Sub-district Symbol (see map)** | **Sub-district name** | **Sub-district center** | **Towns for distance calculation** |
|---|---|---|---|
| **11** | Jerusalem | Jerusalem | Jerusalem, Bet Shemesh |
| **21** | Zefat and Kinneret | Zefat, Tiberias | Zefat, Tiberias |
| **23** | Yizre'el | Afula, Nazareth | Afula, Nazareth, Bet She'an |
| **24** | Akko | Akko | Akko, Karmi'el |
| **31** | Haifa | Haifa | Haifa |
| **32** | Hadera | Hadera | Hadera, Zikhron Ya'akov |
| **41** | Sharon | Netanya | Netanya |
| **42** | Petah Tiqwa | Petah Tiqwa | Petah Tiqwa |
| **43** | Ramla | Ramla | Ramla, Modi'in |
| **44** | Rehovot | Rehovot | Rehovot, Rishon Leziyyon |
| **51** | Tel Aviv | Tel Aviv | Tel Aviv |
| **52** | Ramat Gan | Ramat Gan | Ramat Gan |
| **53** | Holon | Holon | Holon |
| **61** | Ashqelon | Ashqelon | Ashqelon, Qiryat Gat, Qiryat Mal'akhi |
| **62** | Be'er Sheva | Be'er Sheva | Be'er Sheva, Arad, Dimona |
| **70** | Judea and Samaria | Ariel | Ariel, Efrata, Maale Adumim |

For example, to calculate the distance between the Jerusalem sub-district and the Be'er Sheva sub-district six distances were measured: Jerusalem-Be'er Sheva, Jerusalem-Arad, Jerusalem-Dimona, Bet Shemesh-Be'er Sheva, Bet Shemesh-Arad, and Bet Shemesh-Dimona. After this an average for all six distances was calculated. Table of distances is displayed on the next page.

Table A1 – Distances between sub-districts

| | 11 | 21 | 23 | 24 | 31 | 32 | 41 | 42 | 43 | 44 | 51 | 52 | 53 | 61 | 62 | 70 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **11** | | 193.5 | 142.7 | 184.5 | 138.5 | 101.5 | 84.0 | 55.5 | 34.8 | 46.8 | 51.5 | 54.5 | 51.5 | 51.8 | 108.7 | 51.5 |
| **21** | 193.5 | | 53.0 | 50.0 | 72.5 | 98.5 | 118.0 | 138.0 | 155.5 | 164.5 | 150.0 | 153.0 | 155.0 | 197.3 | 275.0 | 186.0 |
| **23** | 142.7 | 53.0 | | 60.8 | 52.7 | 55.0 | 72.7 | 92.7 | 110.2 | 119.2 | 104.7 | 107.7 | 109.7 | 152.0 | 229.3 | 147.1 |
| **24** | 184.5 | 50.0 | 60.8 | | 34.0 | 68.3 | 85.0 | 113.0 | 131.0 | 140.0 | 125.0 | 127.0 | 130.0 | 173.3 | 251.8 | 186.3 |
| **31** | 138.5 | 72.5 | 52.7 | 34.0 | | 37.5 | 66.0 | 86.0 | 104.0 | 113.0 | 98.0 | 101.0 | 103.0 | 146.3 | 223.3 | 138.7 |
| **32** | 101.5 | 98.5 | 55.0 | 68.3 | 37.5 | | 23.0 | 42.5 | 59.8 | 68.5 | 54.0 | 57.0 | 59.0 | 101.3 | 178.3 | 104.2 |
| **41** | 84.0 | 118.0 | 72.7 | 85.0 | 66.0 | 23.0 | | 33.0 | 44.0 | 46.5 | 32.0 | 35.0 | 37.0 | 79.3 | 156.3 | 95.0 |
| **42** | 55.5 | 138.0 | 92.7 | 113.0 | 86.0 | 42.5 | 33.0 | | 18.5 | 23.5 | 10.0 | 6.0 | 15.0 | 70.0 | 146.3 | 62.0 |
| **43** | 34.8 | 155.5 | 110.2 | 131.0 | 104.0 | 59.8 | 44.0 | 18.5 | | 17.8 | 28.0 | 23.5 | 25.5 | 51.5 | 126.8 | 55.0 |
| **44** | 46.8 | 164.5 | 119.2 | 140.0 | 113.0 | 68.5 | 46.5 | 23.5 | 17.8 | | 23.0 | 26.0 | 18.0 | 38.0 | 114.3 | 68.8 |
| **51** | 51.5 | 150.0 | 104.7 | 125.0 | 98.0 | 54.0 | 32.0 | 10.0 | 28.0 | 23.0 | | 3.0 | 5.0 | 60.0 | 136.7 | 65.3 |
| **52** | 54.5 | 153.0 | 107.7 | 127.0 | 101.0 | 57.0 | 35.0 | 6.0 | 23.5 | 26.0 | 3.0 | | 8.0 | 63.0 | 139.7 | 66.0 |
| **53** | 51.5 | 155.0 | 109.7 | 130.0 | 103.0 | 59.0 | 37.0 | 15.0 | 25.5 | 18.0 | 5.0 | 8.0 | | 52.3 | 131.3 | 67.0 |
| **61** | 51.8 | 197.3 | 152.0 | 173.3 | 146.3 | 101.3 | 79.3 | 70.0 | 51.5 | 38.0 | 60.0 | 63.0 | 52.3 | | 83.1 | 88.9 |
| **62** | 108.7 | 275.0 | 229.3 | 251.8 | 223.3 | 178.3 | 156.3 | 146.3 | 126.8 | 114.3 | 136.7 | 139.7 | 131.3 | 83.1 | | 124.6 |
| **70** | 51.5 | 186.0 | 147.1 | 186.3 | 138.7 | 104.2 | 95.0 | 62.0 | 55.0 | 68.8 | 65.3 | 66.0 | 67.0 | 88.9 | 124.6 | |

## Appendix B – Explanatory variables

*Housing density* was calculated as the number of household members divided by the number of rooms in the dwelling[16]. The ratio fell throughout the period in all the sub-districts. On average, the highest housing density is found in the Jerusalem sub-district (1.34 persons per room). Surprisingly, the lowest household density (0.91 persons per room, on average over the period) characterizes the Tel Aviv sub-district (which, being central, should have the highest housing density according to urban theory), where the ratio fell from 1 person per room in 1991 to 0.78 persons per room in 2004. While in the majority of sub-districts the average number of persons per room fluctuates near one, household density is higher than one in the Jerusalem, Yizre'el, Akko, Hadera, Ramla and Judea and Samaria sub-districts.

Average number of young *children* (age 0-4) per household also fell throughout the period in almost all regions. There is substantial deviation between the regions in this ratio, ranging from only 0.2, on average, in the Tel Aviv sub-district to 0.72 in the Judea and Samaria sub-district. In general, the Jerusalem, Yizre'el, Akko, Hadera, Ramla and Be'er Sheva sub-districts have high children-to-household ratios (majority of these sub-districts are also characterized by a high proportion of Arab or Bedouin populations). On the other hand, the Tel Aviv, Ramat Gan and Haifa sub-districts are characterized by extremely low numbers of children aged 0-4 per household (lower than 0.25 children per household, on average).

The proportion of the *most mobile labor force* is measured by percentage of males age 25-34 with 13+ years of schooling in the regional labor force; it ranges from only 4.1-4.2 percent in the northern sub-districts of Zefat and Kinneret and Yizre'el to 9.1-9.2 percent in the Tel Aviv and Judea and Samaria sub-districts. The proportion of the most mobile labor force group increased throughout the period under investigation in all regions, mainly as a result of a substantial rise in the proportion of highly educated people in the labor force.

Long term moving averages of regional *unemployment rates* were the highest in the Ashqelon, Ramla, Be'er Sheva and Haifa sub-districts and relatively low in the Judea and Samaria, Ramat Gan, Rehovot, Tel Aviv and Petah Tiqwa sub-districts.

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[16] In Israel, the accepted measure of "number of rooms" in a dwelling includes both living room and bedrooms, unlike in other countries where only bedrooms are counted.

The *employment density* variable is calculated as the number of employed persons in the sub-district divided by its labor force size and is used as a proxy for labor demand factors in the local labor market. In the Tel Aviv sub-district the ratio was much higher than in other regions, near 1.6. This high ratio of employed to labor force confirms the region's employment orientation. The Jerusalem, Zefat and Kinneret, Haifa and Ramla sub-districts had ratios near 1 throughout the whole period. It can be argued that these regions could, in general, provide employment opportunities to all their residents. It can be also speculated that in- and out-commuting in these regions result from occupational or skills mismatch between labor demand and supply. In distinct contradiction to these regions, the Holon and Judea and Samaria sub-districts provided jobs for half their labor forces only. In other regions, jobs are available for 70-84 percent of the labor force. Those who cannot find jobs within residential regions are forced to commute or become unemployed. For instance the high unemployment rate in the Be'er Sheva sub-district can be explained, on the one hand, by relatively low employment density (employed to labor force ratio of 80-86 percent in various years) and on the other hand, by very weak out-commuting flows.

Economic sectors for *wagemix* index (CBS):
(1) Agriculture
(2) Manufacturing
(3) Electricity and water supply
(4) Construction (building and civil engineering projects)
(5) Vehicles, wholesale and retail trade (incl. repair of motor vehicles, motorcycles and personal and household goods)
(6) Accommodation services and restaurants
(7) Transport, storage and communication
(8) Banking, insurance and other financial institutions
(9) Real estate, renting and business activities
(10) Public administration
(11) Education
(12) Health services and welfare and social work
(13) Community, social and personal and other services
(14) Private households with domestic personnel

*Table B1 – Averages of explanatory variables, by sub-districts, years 1991-2004 (standard deviations in parentheses)*

| **Sub-district** | **Housing density** | **Number of children age 0-4 per household** | **Proportion of males age 25-34 with 13+ years of schooling in labor force, percent** | **Ten-years moving average of unemployment rate, percent** | **Employment density** | **Weighted wage index (*wagemix*) in constant 2000 prices, NIS** |
|---|---|---|---|---|---|---|
| **Jerusalem** | 1.34 (0.13) | 0.54 (0.05) | 7.91 (0.72) | 8.12 (0.34) | 0.97 (0.04) | 36.70 (3.64) |
| **Zefat and Kinneret** | 1.05 (0.07) | 0.38 (0.05) | 4.11 (0.81) | 8.13 (0.50) | 0.94 (0.06) | 34.19 (3.72) |
| **Yizre'el** | 1.21 (0.09) | 0.45 (0.02) | 4.56 (1.21) | 8.10 (0.41) | 0.80 (0.04) | 34.77 (3.82) |
| **Akko** | 1.28 (0.11) | 0.51 (0.05) | 4.93 (1.22) | 8.80 (0.70) | 0.70 (0.03) | 35.08 (3.69) |
| **Haifa** | 0.97 (0.09) | 0.24 (0.05) | 6.96 (0.78) | 9.44 (0.94) | 0.98 (0.04) | 35.81 (3.45) |
| **Hadera** | 1.22 (0.10) | 0.47 (0.03) | 5.29 (1.04) | 8.48 (0.66) | 0.71 (0.03) | 35.20 (3.52) |
| **Sharon** | 1.07 (0.09) | 0.35 (0.03) | 5.38 (1.18) | 8.02 (1.19) | 0.72 (0.04) | 34.29 (3.56) |
| **Petah Tiqwa** | 0.97 (0.07) | 0.31 (0.03) | 6.66 (1.31) | 7.14 (0.43) | 0.76 (0.05) | 35.15 (3.53) |
| **Ramla** | 1.14 (0.10) | 0.41 (0.04) | 4.16 (1.56) | 10.17 (0.63) | 1.03 (0.10) | 36.29 (3.50) |
| **Rehovot** | 0.98 (0.07) | 0.30 (0.02) | 6.04 (1.06) | 7.05 (0.63) | 0.70 (0.03) | 35.33 (3.49) |
| **Tel Aviv** | 0.91 (0.10) | 0.20 (0.04) | 9.08 (2.09) | 7.21 (0.53) | 1.63 (0.04) | 36.31 (3.67) |
| **Ramat Gan** | 1.03 (0.08) | 0.33 (0.05) | 7.80 (1.08) | 6.59 (0.37) | 0.83 (0.05) | 36.28 (3.72) |
| **Holon** | 1.01 (0.07) | 0.23 (0.03) | 5.38 (0.58) | 7.85 (1.03) | 0.50 (0.03) | 35.10 (3.36) |
| **Ashqelon** | 1.06 (0.07) | 0.37 (0.03) | 4.74 (1.03) | 11.53 (1.50) | 0.77 (0.02) | 35.41 (3.82) |
| **Be'er Sheva** | 1.06 (0.06) | 0.42 (0.03) | 6.04 (0.65) | 9.97 (0.81) | 0.84 (0.02) | 35.07 (3.53) |
| **Judea and Samaria** | 1.10 (0.06) | 0.72 (0.09) | 9.17 (1.94) | 4.92 (0.61) | 0.50 (0.04) | 37.18 (4.15) |