

# **Decomposing the Dynamics of Regional Earnings Disparities in Israel**

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## **Abstract**

The literature on regional growth convergence and economic disparities has tended to confound four interwoven measurement phenomena. i) *mean reversion* (so-called beta convergence) where richer regions move towards the average from above and poorer regions from below. ii) *diminishing inequality* (so called sigma convergence) where the horizontal or spatial distribution of income becomes more equal. iii) *mobility*, where the rank of a region in the overall distribution of income changes either upwards or downwards. iv) *leveling*, where the richer regions become poorer (leveling-down) or the poorer regions become richer (leveling-up). We use a new statistical methodology, which treats these four phenomena on an integrated basis. The methodology is applied to Israeli regional earnings and house price data. We find that whereas earnings are strongly sigma divergent during the 1990s, this trend is offset when regional cost of living differences are taken into consideration. In this event, regional housing markets induce convergence in similar measure to the divergence induced by regional labor earnings.

## **1. Introduction**

The study of trends in income disparities both between countries and between regions within countries has captured widespread attention (Armstrong 1995, Barro and Sala-i-Martin 1991, Baumol 1986, Quah 1996, Tsionas 2000,2001). These studies have been motivated by what might be called the “expanding universe” and “contracting universe” schools of economic activity. According to the latter school, variables such as GDP per head should be converging upon some common value as predicted by neoclassical theory. Regional inequalities are unlikely to persist due to self-correcting mechanisms in labor and capital markets (Sala-I-Martin 1996). According to the “expanding universe” school convergence is not necessarily expected and GDP per head may even diverge, as predicted by the so-called New Growth Economics (Romer, 1986).

The forces of convergence are likely to be greater within countries than between them for several reasons. First, capital mobility and trade, which engender convergence between countries, are likely to be greater within countries than between them. Secondly, labor is generally immobile between countries, but is mobile within them, so that workers will tend to migrate to regions where wages are higher. Labor mobility therefore reinforces capital mobility and trade in inducing wage convergence within countries. Third, if the country happens to be small so that commuting is feasible, people will prefer to work in better paying regions and live where living costs, especially housing, are cheaper. This too will reinforce convergent forces.

Various reasons have been offered for regional income divergence. Some argue that market forces tend towards spatial disequilibrium and that uneven regional development is self-entrenching rather than self-correcting (Myrdal 1957, Kaldor 1970). Others claim that convergence between nations and regions can only be observed when attention is restricted to richer countries or regions and ‘club convergence’ is then observed (Chatterji 1992). This view has theoretical roots in Krugman’s (1991) general model of spatial concentration in which there may exist multiple equilibria. Poor regions may converge toward an inferior equilibrium as the gap between them and the leading regions is too wide to bridge. Most studies point to some form of slow convergence through the 1970’s and 1980’s, which petered out in the 1990s (Martin 2001, Tsionas 2000, 2001, de la Fuente 2002). This is true for regional convergence at the supra-national level such as the EU (Armstrong 1995) and also at the level of the individual country (Cuardo-Roura 1999, Hofer and Worgotter 1997, O’Leary 2001).

In this paper we contribute to this debate in three ways. First, the literature has tended to confuse the interrelated concepts of mobility, beta convergence and sigma convergence. Below we bring examples from the literature of this confusion, and we seek to clarify these concepts. In doing so we use regional earnings data for Israel to answer the following questions:

- Has inequality between regions been increasing or decreasing? If inequality is measured by the variance this amounts to asking whether or not there has been sigma convergence<sup>1</sup>. If, instead, inequality is measured by Gini, this amounts to asking whether there has been Gini convergence.
- How mobile are regional earnings, and has this mobility been increasing or decreasing? A region is said to be upwardly mobile if its rank or position in the distribution changes for the better, and downwardly mobile if it changes for the worse. We refer to this type of mobility as rank-mobility.
- Another kind of mobility is measured by regression toward the mean, or beta convergence, where poorer regions grow faster and richer ones grow slower. We refer to this as quantity-mobility. Note that upward rank-mobility and downward quantity-mobility, or vice-versa, may coexist. Income may increase relative to the mean at the same time as rank in the distribution happens to fall. We ask whether beta convergence has occurred between regions, and whether it has been increasing or decreasing over time. We also ask whether rank-mobility and quantity-mobility have been in the same direction.
- Finally, has the gap between poorer regions and richer regions narrowed because richer regions have become less well-off (leveling-down), or has there been leveling-up?

We show that all these questions are essentially different and deal with different aspects of regional disparity.

A second objective is to define regional earnings taking into account regional cost of living differentials. Almost all the literature has ignored differences in regional prices when analyzing patterns of convergence<sup>2</sup>, yet those few studies that have addressed the matter

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<sup>1</sup> We use this term generically to refer to diminishing inequality rather than to the specific use of the standard deviation to measure inequality.

<sup>2</sup> Previous work has been surprisingly uniform in its choice of indicators for observing regional disparities and measurement approaches. Studies focusing on the US have invariably used State Income per capita (Lall and Yilmaz 2001, Rey and Montouri 1999) or Gross State Output (Tsionas 2000). Work concentrating on EU countries, is generally conducted at the spatial scale dictated by European statistical data collection (NUTS1,

(Johnston, McKinney and Stark 1996, and Eberts and Schweitzer 1994) have shown that these price differentials play an important role in regional convergence. Therefore we distinguish between regional earnings deflated by national price indices, and earnings deflated by regional specific price indices. Earnings might not converge due to weak equilibrating forces in regional labor markets, while earnings adjusted for regional differences in living costs may nonetheless converge, because house prices behave as an equilibrating phenomenon.

The literature has tended to ignore regional price differences because the necessary data are generally not available. Several initiatives are currently underway to rectify the matter. Nor are these data available in Israel. In the meanwhile we propose a methodology to construct regional price data from existing sources on house prices and on other goods and services.

A third objective is to investigate “Amenity Theory” (Glaeser, Kolko and Saiz 2000) which predicts that regions with poorer endowments of amenities (public services, physical attributes, social attributes, public safety etc) will compensate by offering higher relative wages, either because wage rates are higher there and/or because the cost of living is lower. In Israel this means that Tel Aviv, which arguably is abundant in amenities, should have earnings that are relatively low, after allowing for cost-of-living differentials, whereas the opposite should apply in areas like the Negev region where amenities are less abundant. We ask whether the pattern of wage disparities in Israel is consistent with the regional distribution of amenities.

## **2. Growth and Regional Inequality: The Israeli Context**

While economic disparities have featured high on the national agenda in Israel there has generally been an absence of any uniform framework for analysis, and a dearth of solid empirical evidence of regional inequalities over time. The social cleavages between Jews and Arabs, Ashkenazi and Mizrahi Jews and the ultra-orthodox and secular Israelis have distinct geographic patterns that further conflate economic disparities. Earlier work has looked at individual aspects of regional disparities in Israel since the foundation of the state in 1948. Areas such as industrial subsidies (Razin and Schwartz 1992, Bregman, Fuss and Regev 1998), housing provision (Krakover and Aharonovich 1998), infrastructure investment (Bar El 2001),

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NUTS2) and relates to GDP per capita or GVA per worker as the main indicators (Barro and Sala-i-Martin 1991, Armstrong 1995, Martin 2001, Chatterji and Dewhurst 1996, Cuadro-Roura et al 1999).

local public finance (Razin 1998) or quality of life indicators (Lipshitz 1993, Lipshitz and Raveh 1998) have attracted piecemeal attention. Portnov (2002) has surveyed a large number of diverse indicators finding spatial divergence in some (population, income distribution, labor force participation) and convergence in others (education, housing density etc). However, there has been no systematic attempt to measure the existence of regional disparities and to use composite variables that reflect different aspects of economic and social life (for example, earnings on the production side and housing costs on the consumption side).

Much of the debate around regional inequalities focuses on the public policy instruments used since the 1950's designed to reduce them. However, their efficiency in the face of processes of globalization and new economy-fuelled growth, is constantly declining (Gabriel, Justman and Levy 1987, Razin and Schwartz 1992 ). In regional terms, the economic growth of the 1990's affected only certain groups in the population in a particular narrow band of economic and occupational sectors that have their own distinctive locational patterns (Jerby and Levi 2000, Kop 2000). This point is further underscored by the fact that disparities in Israeli society have a distinct spatial pattern. Existing economic and ethnic cleavages (for example, between Jews and Arabs) are reinforced by spatial regional disparities. In this way regional and economic forces coalesce (Lewin-Epstein and Semyonov 1994).

It should be noted that Israel is a small country occupying a land mass of some 20,000 sq km and with a population of 6.5m. As a result, Israeli regions are small and exhibit great variation in population densities. Amongst the nine regions used in this study (see below, Map 1) there is an inverse relationship between physical size and population size with a few small, densely populated regions home to the majority of the national population. In this respect Israel is hardly different to other small, developed countries such as Denmark (42,300 sq km and 5.3m population), Switzerland (40,000 sq km and 7.2 m population), Ireland (69,000 sq km and 4.0 m population), and Belgium (30,000 sq km and 10.2m population). Given the small dimensions of the country, we would expect significant inter-regional movement. However, empirical data on inter-regional commuting across the 1990's show that most regions are self-contained labor markets with more than 85% percent of residents working in the region. This is a higher level of insularity than the 75% share commonly adopted for defining local labor market areas or travel to work areas (Smart 1974). Sub-regions within the metropolitan areas

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exhibit large commuting flows with contiguous areas (as is the case between the Tel Aviv, Dan and Sharon areas and the Haifa and Krayot areas). Outside these two metropolitan centers however, higher levels of employment insularity are registered.

### 3. Method and Data

#### 3.1 A Neoclassical Benchmark Model

The neoclassical model of regional equilibrium (Siebert, 1969) assumes varying combinations and degrees of mobility in capital, labor and goods. Here, we introduce into the model the stock of building land ( $H$ ), which is fixed but is assumed to vary by region. There are  $N$  regions and the national population ( $L$ ) is assumed to be fixed. The cost of living in region  $i$  is equal to  $P_i = P^a P_{Hi}^{1-a}$ , where  $0 < a < 1$ ,  $P$  denotes the price of traded goods, which is assumed to be equalized by free trade between regions, and  $P_H$  denotes the price of housing services. There is a common, constant-returns-to-scale production technology given by  $Q_i = AK_i^b L_i^{1-b}$ , where  $K$  and  $L$  denote capital and labor respectively and  $0 < b < 1$ .  $Q$  is tradeable and is sold at common price  $P$  in all regions. Finally, the demand for housing services or space in region  $i$  is assumed to vary directly with the population in the region and regional earnings, and inversely with the price of housing services:  $H_i^D = L_i(P_{Hi}/P)^{-c}(W_i/P_i)^d$ .

The structural parameters,  $a$ ,  $b$ ,  $c$ , and  $d$  do not vary by region, hence the regional equilibrium described below is symmetric, except for the fact that  $H_i$  varies. In equilibrium the supply of housing services is equal to demand, hence  $H_i^D = H_i$ . In all other respects, such as amenity endowments, all regions are assumed to be identical.

Table 1 here

Table 1 reports various regional equilibria under different assumptions about factor mobility. Capital, labor and goods markets are assumed to be competitive and firms are assumed to maximize profits.  $\pi_2$ ,  $\pi_4$ , and  $\pi_7$  are ambiguously positive. So are the other  $\pi$  coefficients provided the income elasticity of demand for housing ( $d$ ) does not exceed unity by too much. If both factors are mobile the regional distribution of employment (population) depends entirely on the regional distribution of building land. In this case house prices are equalized across regions and so are earnings. If labor is immobile, the mobility of capital ensures that earnings are equalized, but house prices will be relatively expensive in regions where the relative demand for housing is higher, i.e. with greater  $L/H$ .

This means that although earnings are equalized, real earnings ( $W_i/P_i$ ) are lower in regions where relative housing demand is greater. Finally, if capital is immobile and labor is mobile real earnings ( $W_i/P_i$ ) must be equalized, but earnings and house prices must vary between regions. House prices will be relatively high in regions well endowed with capital, because labor will be attracted there, and relatively low in regions well endowed with building land. The same applies to the regional distribution of earnings. The regional distribution of employment (population) varies directly with relative endowments of capital and building land.

Note that if commuting occurs,  $W_i = W_j$  and  $P_{Hi} = P_{Hj}$  even if capital is immobile. Hence, commuting creates the same regional equilibrium as labor and capital mobility. In general, however, Table 1 establishes that real earnings will tend to differ across regions under Classical equilibrium, unless labor happens to be perfectly mobile. Capital mobility and trade are not sufficient conditions for real earnings equality in our model because the regional distribution of building land is not necessarily uniform.

### 3.2 Beta and Sigma Convergence

In the economic growth literature, the existence of regional convergence or divergence has traditionally been measured using two indices of convergence. The first is  $\beta$ -convergence, which measures regression towards the mean, or mean reversion. The second is  $\sigma$ -convergence, which measures declining variance over time, or increasing equality. Ever since Galton's Paradox expounded in the 19<sup>th</sup> century (Quah, 1993) it has been known that  $\beta$ -convergence does not imply  $\sigma$ -convergence. In this section we outline the relationship between these two concepts.

Let  $X_{it}$  represent the value of  $X$  observed in region  $i$  at time period  $t$ . The statistical model for  $X$  is assumed to be:

$$X_{it} = \alpha + \beta X_{it-1} + u_{it} \quad (1)$$

$$u_{it} = \rho u_{it-1} + v_{it} \quad (2)$$

where the absolute value of  $\rho$  is less than unity, and  $v_{it} \sim N(0, \sigma_v^2)$ . If equation (1) is estimated by ordinary least squares using cross-section data then it may be shown that:

$$\hat{\beta} = \beta + \rho \frac{(1-\beta)^2}{(1-\beta\rho)} \quad (3)$$

$$\frac{\sigma_{X_t}}{\sigma_{X_{t-1}}} = \frac{\hat{\beta}}{r} \quad (4)$$

where  $\sigma_X$  denotes the cross-section standard deviation of  $X$ , and  $r$  is the correlation coefficient between  $X_{it}$  and  $X_{it-1}$ .

Beta convergence implies  $0 < \beta < 1$ , and sigma convergence implies  $\sigma_{X_t} < \sigma_{X_{t-1}}$ . Equation (3) shows that  $\beta$  is overestimated if  $\rho > 0$ . Equations (2), (3) and (4) establish the following propositions:

- i) Sigma convergence necessarily implies beta convergence. Equation (4) implies that  $\beta < r$  when there is sigma convergence, and since  $1 \geq r$ , it follows that  $0 < \beta < r$ .
- ii) Sigma divergence does not necessarily imply beta divergence. Equation (4) implies  $\beta > r$  when there is sigma divergence, but if  $r < \beta < 1$ , sigma divergence coexists with beta convergence.
- iii) Beta divergence necessarily implies sigma divergence because  $\beta$  must exceed  $r$ .
- iv) Beta convergence does not necessarily imply sigma convergence. Equation (4) implies that beta convergence and sigma convergence coexist when  $\beta < r$ .
- v) If  $\rho > 0$  beta convergence is underestimated.

We compare these propositions with statements made by Barro and Sala-I-Martin (1995) in the context of regional convergence, and by Mulligan (1997) in the context of intergenerational convergence. There are many other examples that we could have taken. Mulligan correctly states (p168) that beta divergence implies sigma divergence, which agrees with proposition iii). He also states that beta convergence either implies sigma convergence or sigma stability, he rules out sigma divergence. This is incorrect, because according to proposition iv) beta convergence implies sigma divergence if  $\beta > r$  <sup>3</sup>.

Matters are yet more confusing in Barro and Sala-i-Martin (1995). They assume away a large part of the problem by assuming (p384) in equation (1) that  $E(X_{it-1}, u_{it}) = 0$ , which is equivalent to restricting  $\rho = 0$ . According to proposition v) this implies that estimates of  $\beta$  are necessarily unbiased. They then use equation (1) to produce the following difference equation in the cross-section variance of  $X$ :

$$\sigma_{X_t}^2 = \beta^2 \sigma_{X_{t-1}}^2 + \sigma_v^2 \quad (5)$$

They argue that if there is beta convergence, equation (5) is a stable first-order difference equation in the cross-section variance of  $X$ . If this variance converges from below there is sigma divergence, and if it converges from above there will be sigma convergence.

Their mistake is to forget that  $\beta$  is not independent of the cross-section variance of  $X$ . To see this we substitute equation (4) into equation (5) to obtain:

$$\sigma_{X_t}^2 = \frac{\sigma_v^2}{1 - r^2} \quad (6)$$

which implies sigma stability provided the variance of  $v$  does not change over time.

### 3.3 Measuring the Dynamics of Regional Disparities

In section 3.2 mobility is defined entirely in terms of changes in earnings. No importance is attached to changes in the rank of earnings in the distribution. It is possible that earnings increase over time while worsening the rank. Mulligan (1997) does not distinguish between mobility in earnings and mobility in their rank in the distribution. We follow Wodon and Yitzhaki (2001) in distinguishing between these two phenomena, and by measuring inequality by Gini. A policy that improves an individual's relative earnings, but lowers his rank in the distribution is very different to a policy, which improves both relative earnings as well as rank.

Wodon and Yitzhaki suggest the following decomposition for  $\beta$  obtained from a Gini regression of  $Y_{it}$  on  $Y_{it-1}$ . We refer to this "Gini" beta by  $\beta^*$ .

$$\beta_t^* = \Gamma_{t,t-1} \frac{G_t}{G_{t-1}} \frac{\bar{Y}_t}{\bar{Y}_{t-1}} \quad (7)$$

where  $G_t$  is the Gini coefficient measuring inequality in  $Y$  between  $n$  regions at time  $t$ .

Following Schechtman and Yitzhaki (1987), Gini may be defined as:

$$G_t = \frac{2 \text{cov}(Y_{it}, R_{it})}{\bar{Y}_t} \quad (8)$$

where  $R_{it} = F(Y_{it})$  is the rank of  $Y_{it}$  over  $n$  in ascending order. Inequality will have decreased between periods  $t-1$  and  $t$  if  $G_t < G_{t-1}$ <sup>4</sup>. In equation (7)  $\Gamma_{t,t-1}$  denotes the Gini correlation between  $Y$  in period  $t$  and income rank in period  $t-1$ . It is defined as:

$$\Gamma_{t,t-1} = \frac{\text{cov}(Y_{it}, R_{it-1})}{\text{cov}(Y_{it}, R_{it})} \quad (9)$$

and is bounded between 1 and  $-1$ . It measures the degree of (backward) mobility.  $Y$  is perfectly immobile when  $\Gamma = 1$ . If  $\Gamma = 0$  there is random mobility because it is not possible to infer  $R_{it-1}$  using information on  $Y_{it}$ . For all practical purposes this represents the case of complete mobility. When  $\Gamma = -1$  there is perfectly perverse mobility: the richest swaps rank with the poorest, the second most rich with the second most poor, and so on.

Equation (7) shows that beta depends upon three factors. It varies directly with the degree of rank immobility ( $\Gamma$ ). It also varies inversely with the degree of Gini convergence

<sup>3</sup> It is difficult to understand why Mulligan makes these errors, because on p165 he reproduces equation (4). Wodon and Yitzhaki (2001) also derive equation (4) independently.

<sup>4</sup> It is possible but unlikely, that while inequality as measured by Gini decreases the variance of  $Y$  may in fact increase since  $\sigma_t > \sigma_{t-1}$ . Hence,  $\sigma$ -divergence may coexist with declining inequality as measured by Gini.

as measured by  $G_t/G_{t-1}$ . Finally it varies directly with the rate of leveling-up as measured by  $\bar{Y}_t/\bar{Y}_{t-1}$ , which exceeds unity in the event of leveling-up and is less than unity in the event of leveling down. If all three components happen to equal unity, then  $\beta^* = 1$  and the rate of mean reversion is zero. If  $\Gamma = 0$  then  $\beta^* = 0$  regardless of the rates of Gini convergence and leveling. Equation (7) implies that one cannot infer Gini convergence or divergence from beta convergence or divergence, and vice-versa. This is very different from the relationship between beta and sigma convergence in section 3.2. Finally, equation (7) implies Gini convergence when:

$$\phi = \frac{\beta^*}{\Gamma_{t,t-1}} \frac{\bar{Y}_t}{\bar{Y}_{t-1}} < 1 \quad (10)$$

Note that in general  $\Gamma_{t,t-1}$  differs from  $\Gamma_{t-1,t}$ , i.e. backward and forward measures of mobility differ, unless  $Y_{it-1}$  and  $Y_{it}$  happen to be exchangeable. The problem is similar to the common index number effect, where for example, the rate of inflation depends upon the direction of measurement. Yitzhaki and Wodon (1999) have suggested a symmetric Gini mobility index, which weights the forward and backward measures of mobility, defined as:

$$S_t = \frac{G_{t-1}(1 - \Gamma_{t-1,t}) + G_t(1 - \Gamma_{t,t-1})}{G_{t-1} + G_t} \quad (11)$$

$S$  is naturally bounded between 0 (no mobility) and 2 (perfectly perverse mobility). When  $S = 1$  mobility is random. Note that if  $Y_{it}$  and  $Y_{it-1}$  are exchangeable  $\Gamma_{t-1,t} = \Gamma_{t,t-1} = \Gamma_t$  in which case  $S_t = 1 - \Gamma_t$ . Note also that this measure of mobility does not require arbitrary definitions of mobility matrices in which intra-decile mobility is given zero weight. We measure regional inequality by Gini ( $G$ ), mobility by  $S$  and mean reversion by  $\beta^*$ . These parameters are calculated for different years, so that their behavior over time can be monitored.

### 3.4 Regional Cost of Living and Convergence

As mentioned in section 1, we are particularly interested in regional disparities in average earnings ( $W_{it}$ ) deflated by local differences in living costs ( $P_{it}$ ). Let  $Y_{it} = W_{it}/P_{it}$  denote average real earnings in region  $i$  in time period  $t$ . Since the relationship between the Ginis for  $Y$  ( $G_Y$ ),  $W$  ( $G_W$ ) and  $P$  ( $G_P$ ) is messy we simplify the relationship between these variables by using their logarithms. Denoting logarithms by lower case letters, for example,

$\log Y = y$ , and dropping time subscripts for convenience, we use the following relationship for the Gini for  $y = w - p$ , where  $G_Y > G_y$ <sup>5</sup>:

$$G_y^2 = G_w^2 + G_p^2 - 2\Gamma_{wp} G_w G_p \quad (12)$$

$$\Gamma_{wp} = \frac{\text{cov}(w_i, R_{ip})}{\text{cov}(w_i, R_{iw})} \quad (13)$$

$\Gamma_{wp}$  is the Gini correlation between  $w$  and  $p$ . If living costs are greater in richer regions then  $\Gamma_{wp} > 0$ . Note that equation (12) implies that Gini convergence in  $y$  may be consistent with Gini divergence in either or both of  $w$  and  $p$ . To see this, suppose that Gini for  $w$  and  $p$  do not change, but the Gini correlation between them increases, equation (12) shows that Gini convergence in  $y$  will have taken place. If the Gini correlation between  $w$  and  $p$  is unchanged, and there is Gini convergence in  $w$  and  $p$ , equation (12) shows that this does not necessarily imply Gini convergence in  $y$ . Further, Gini divergence in  $w$  will only imply Gini divergence in  $y$  when  $G_w > \Gamma_{wp} G_p$ , and Gini divergence in  $p$  will only imply Gini divergence in  $y$  when  $G_p > \Gamma_{wp} G_w$ .

### 3.5 Measuring Regional Cost of Living Disparities

Cost of living differentials and their determination constitute an integral part of the regional adjustment process. The regional cost of living is likely to vary directly with regional economic prosperity, both because house prices and the price of non-traded services are likely to be higher. In terms of purchasing power parity (PPP), prosperous regions will therefore be less prosperous and depressed regions less depressed than the raw data suggest, and as noted in section 1, this may make a large difference to the measurement of regional disparity and its dynamic analysis.

Unfortunately, in common with most countries, regional cost of living data are not available in Israel. However, regional house price data are available. We therefore adopt the following approach, which may be more generally applicable. We distinguish between 3 types of goods that differ in their degree of tradability:

- *Housing* is completely non-tradable. Therefore house prices ( $P_H$ ) will tend to vary between regions.
- *Services* are partially tradable. Some services, such as haircuts, are most probably non-traded; consumers prefer to consume these services locally. In this case, lower regional wages and rents can be expected to lower the price of

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<sup>5</sup> Note that just as  $\text{var}(a + b) = \text{var}(a) + \text{var}(b) + 2 \text{cov}(a,b)$ , so  $G(a + b)$  implies equation (11).

services ( $P_S$ ). Their cost is therefore likely to be proportionate to earnings ( $W$ ). Other services, such as house repairs, are tradable; supply may be imported from another region.

- *Traded Goods* are entirely tradable since they can be exported and imported between regions. The so-called “law of one price” asserts that the prices of traded goods ( $P_T$ ) will be the same across regions.

It might be thought that in a small country such as Israel there is no need for considering regional cost of living disparities beyond regional differences in house prices (Beenstock and Peleg 2000). However, there is prima facie evidence that the cost of services differs substantially between the regions of Israel, so that housing costs are not the sole source of inter-regional cost of living differentials.

We define the cost of living in region  $i$  to be a geometrically weighted average of  $P_T$ ,  $P_H$  and  $P_S$ .  $P_T$  is assumed initially to be identical across regions,  $P_H$  varies across regions, and  $P_S$  (for which we have no data) is assumed to vary directly with regional earnings<sup>6</sup>. Hence:

$$P_{it} = P_{Tt}^\alpha P_{Hit}^\beta W_{it}^{1-\alpha-\beta} \quad (14)$$

where  $\alpha$  denotes the share of traded goods in the consumption basket, and  $\beta$  the share of housing<sup>7</sup>.

### 3.6 Data

We have already noted that regional GDP data are not available in Israel. Earnings data are also not published on a regional basis (with the exception of industrial earnings). For the empirical analysis, we therefore construct earnings data for  $W_{it}$  using the Household Income Survey (HIS). This is an annual survey covering approximately 13,000 respondents conducted by the Israel Central Bureau of Statistics (CBS). The finest spatial detail in HIS is the sub-district of which there are eighteen (Map 1). This is an administrative definition

<sup>6</sup> In practice this assumes that the rate of growth of productivity in the service sector is constant, and that non-labor costs in the service sector are common across regions.

<sup>7</sup> Note that because  $P_{Tt}$  is the same in each region, one does not require data for it. Let  $Y_{0t} = W_{0t}/P_{0t}$  in the base region ( $i = 0$ ) and let  $Y_{it} = Y_{it}/Y_{0t}$  be relative real earnings in region  $i$  at time  $t$ . Equation (14) implies:

$$Y_{it} = \left( \frac{W_{it}}{W_{0t}} \right)^{\alpha+\beta} \cdot \left( \frac{P_{H0t}}{P_{Hit}} \right)^\beta \quad (15)$$

Equation (15) expresses relative real earnings in terms of  $W$  and  $P_H$  for which data are available, and obviates the need for  $P_T$  and  $P_S$  for which data may be unavailable.

used by the CBS. While these districts do not correspond to economic or functional zones (such as labor or commuting sheds), data availability dictates their use. Data are available at this level of disaggregation for the period 1991-1999. In addition, we have been able to obtain data at the sub-district level for the period 1975/6<sup>8</sup>. HIS has been used to construct average (simple and weighted) earnings for each sub district for the years 1975, 1976 and 1991-1999. For other years HIS does not contain information at the sub-district level. This means that we can investigate regional earnings disparities in the 1990s using data for the mid 1970s as an historical benchmark.

Map 1 here

Since the early 1970s CBS has published quarterly regional house price indices based on transactions data for houses of different sizes in 9 regions<sup>9</sup>. These regions correspond to some of the larger individual sub-districts and to combinations of sub-districts. For example, the Tel Aviv and Jerusalem regions are identical to the Tel Aviv and Jerusalem sub-districts, the Central region incorporates the smaller sub-districts of Ramle, Petach Tikva and Rehovot, while the Southern region comprises the Ashkelon and Beer Sheva sub-districts and so on. Thus, while  $W$  may be calculated at the sub-district level,  $Y$  can only be calculated at the 9-region level and this dictates the spatial disaggregation of our analysis.

Price indices for traded goods have been published by the Bank of Israel. The weights in equation (15) represent expenditure on traded goods and housing. These are national weights derived from the CBS Family Expenditure Survey (FES) 1997. The weights are  $\alpha = 0.543$  and  $\beta = 0.207$ . Their counterparts from FES 1976 are 0.612 and 0.207. Because FES is not generally available on a regional basis it is not possible to disaggregate these weights by region.

## 4. Empirical Results

### 4.1 Presentation of the Data

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<sup>8</sup> These data were made available by the ISDC (Social Science Data Archive) at the Hebrew University.

<sup>9</sup> It should be noted that while earnings data come from a survey, house price data represent actual transactions. There is no real correspondence between these two sources and this could be a cause of bias for certain sub-populations. For example, the Arab sector is covered by the earnings data but records very few transactions in the housing market. Consequently there could be inconsistencies in the sampling frames of  $W$  and  $P$ . While the measurement of user cost of housing is problematic, we prefer house prices over rents as the rental market in Israel is very small.

We begin by plotting the data for regional earnings over time in the 9 regions (Fig 1). As can be seen, during the 1990s the Tel Aviv region consistently appears at the top of the distribution while the Northern region is consistently located at the bottom. Between these two extremities there is some shifting of positions. Note that in 1976 the rankings were rather different, with the Dan region topping the distribution. In terms of regional house prices (Fig 2) the top four regions retain their ranks over the 1990's with more movement and switching amongst the bottom five regions. Housing is most expensive in the Haifa region and least expensive in the Southern and Northern regions. Note that between 1976 and 1991 the ranks hardly change.

When plotting the data (Fig 3) for average real earnings,  $Y_{it} = W_{it}/P_{it}$ , i.e. regional disparities in earnings deflated by local differences in cost of living, the picture changes. Overall, we observe more shifting between regions. In terms of individual regions, Tel Aviv is replaced by the Central region at the top of the distribution. At the other end of the scale, the Sharon region replaces the Northern and Southern regions at or near the bottom with the Jerusalem region also ranked consistently low throughout the first half of the period. Note that in 1976 the Dan region was ranked first, while Jerusalem was ranked last.

(Figs 1-3 here)

#### 4.2 Dynamics of Regional Economic Disparities

Looking at the disparities over time, the main picture that emerges is one of earnings convergence between 1976 and 1990. As noted in section 1, this pattern is observed in many other developed countries. However, in the 1990s earnings diverge and become as unequal as they were in 1976. This pattern too is observed elsewhere. For example, the Gini index for earnings in the 9-regions (Fig 4) almost doubled between 1991 and 1999, rising from 0.0227 to 0.0398. In 1976 the regional Gini for earnings was 0.04. Because the data are regional averages they conceal intra-regional inequality, hence both the level and the change in Gini are smaller than one typically encounters with data for individuals<sup>10</sup>.

Fig 4 here

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<sup>10</sup> Denoting Gini for individuals by  $G^*$ , it may be shown (Yitzhaki 1994) that  $G = G^* - \sum_i^n G_i V_i O_i$ , where  $G_i$  denotes Gini for individuals in region  $i$ ,  $V_i$  denotes the share of earnings in region  $i$ , and  $O$  denotes the coefficient of stratification or overlapping. Hence  $G < G^*$ .

The Gini for house prices rose between 1976 and 1991, and fluctuated thereafter. The Gini for real earnings ( $Y$ ), which incorporates house prices, shows that on the whole real earnings were both more equal and less divergent than unadjusted earnings. Over the 1990's the Gini for real earnings rose from 0.021 to 0.031. Between 1976 and 1991 the Gini for real earnings falls, from 0.027 to 0.021, which is a more moderate fall than for unadjusted earnings. From Figure 4 we can observe certain years where local living costs reinforce inter-regional inequality rather than off-setting it (1992, 1995 and 1996 where  $G_Y$  is larger than  $G_W$ ). In these years, living costs were unusually low in rich regions and unusually high in poor ones.

Equation (11) shows that the Gini for real earnings may change even if the Gini for earnings and living costs remain unchanged. The Gini for real earnings varies inversely with the correlation between earnings and living costs. Fig 5 shows that this correlation almost tripled. Without this the degree of Gini divergence would have been even higher. A possible explanation for the growing correlation between earnings and living costs could be government intervention in the housing market over the 1990's. With the mass immigration from the former Soviet Union over this period, the government induced private building contractors to build in the poorer and more peripheral regions of the country. This caused a housing shortage in the richer high-demand regions and prices rose (Beenstock and Peleg 2000).

Fig 5 here

In summary, the evidence seems to show that while earnings were strongly divergent during the 1990s, this effect is suppressed when local living costs are taken into consideration. Moreover, the considerable convergence observed in earnings between 1976 and 1991 overstates the convergence in real earnings during this period. The inclusion of house prices and local living costs makes a substantial difference to the measurement of the dynamics of regional economic disparities.

#### *4.3 Inter-Regional mobility*

Regional mobility in real earnings is measured by the Gini Mobility Index ( $S$ ). Figure 6 shows that the Gini Mobility Index for earnings adjusted for local living costs ( $Y$ ) is about 0.17 in the early 1990s and ranges between 0.05 and 0.10 thereafter, implying that real earnings are immobile from one year to the next. We also calculate this mobility index over several years because it is natural to expect more mobility over a longer time period

than a shorter one (Figure 7). The Gini Mobility Index tends to grow with the length of the measurement period, from 0.16 over the short-term to 0.47 over the longer-term. Figure 7 also shows that between 1976 and 1991 there was a substantial amount of mobility; the Gini Mobility Index is 0.48. Although regions hardly change rank in the short term, they display more mobility in the longer run.

Figure 6 also shows that the short-term mobility regional house prices is virtually zero, and Figure 7 shows that house prices are quite immobile over the long-term too. Figures 6 and 7 show that earnings (uncorrected for local living costs) are on the whole less mobile than adjusted earnings both in the short and long-runs.

Figures 6 and 7 here

#### *4.4 Decomposing Inequality and Mobility*

Figure 8 plots the decomposition of  $\beta$  - convergence into mobility, changes in inequality and leveling over time, as outlined in equation (7). In the absence of mobility ( $\Gamma = 1$ ), Gini convergence, and leveling there must be zero  $\beta$  - convergence ( $\beta = 1$ ). From Figure 8 we can see that over the 1990s  $\beta$  was close to unity. 1992-3 were years of greatest mean reversion ( $\beta = 0.56$ ), which was brought about by Gini convergence, an almost zero rate of leveling, and a somewhat greater degree of mobility. 1991-2 were years of greatest mean diversion ( $\beta = 1.21$ ), which was induced by a particularly high rate of Gini divergence. After 1993/4 the components of  $\beta$  settle down, such that  $\beta$  falls from 1.2 in 1993/4 to 0.9 in 1998/9. This fall was induced by minor, unstructured changes in its components.

Figure 8 here

#### *4.5 Sensitivity Analysis*

Our results show that local living costs make a difference to the dynamic analysis of regional disparities. In this sub-section we investigate the sensitivity of our results to plausible alternative measures of local living costs, in the absence of regional CPIs. In section 3.4 we were obliged to make two data assumptions, that the retail price of traded goods does not vary between regions, and that the weights of the 3 types of goods in the consumption basket are the same in each region. While it may be reasonable to assume that the wholesale price of traded goods does not vary by region, the same is less plausible for

retail prices. Since the retail margin depends, inter alia, upon shop rents and labor costs, the retail prices of traded goods are likely to be lower in regions with lower costs of distribution. Indeed, Lach (2002) has shown for 4 traded goods in Israel that retail prices vary, quite substantially, both within and between regions.

We denote the retail price of traded goods in region  $i$  at time  $t$  by  $P_{Tit}$ , the common wholesale price by  $P_{Tt}$ , and, in the absence of data on commercial rents, assume that shop rents are proportionate to house prices. Regional retail prices of traded goods are assumed to be a geometric weighted average of wholesale prices, house prices and earnings:

$$P_{Tit} = P_{Tt}^{1-\kappa-\eta} P_{Hit}^\kappa W_{it}^\eta \quad (16)$$

The retail margin is  $\rho = \kappa + \eta$ . A survey carried out by CBS in 1999 suggests that  $\rho = 0.35$  and that  $\kappa = .0728$ . Applying these estimates to equation (16) and substituting the result into equation (14) implies that the weight on the wholesale price of traded goods falls to 0.472 from 0.543, and the weight on housing prices rises to 0.218 from 0.207.

Calculating earnings adjusted for local living costs on this basis implies that earnings during the 1990s were both more equal and less divergent (Figure 9). We find that the greater the weight on house prices, and the lower the weight on the price of traded goods, the less Gini divergent are real earnings. Indeed, when the weight on traded goods is less than 0.432 and the weight on house prices is greater than 0.280 real earnings become Gini convergent instead of Gini divergent.

Figure 9 here

#### 4.6 Explaining the Absence of Convergence

In common with the empirical literature that has been cited we have assumed by default that the regions are demographically homogeneous and that regional economic differentials are not affected by the demographic composition of the employed. In Israel, as elsewhere, there is a large body of empirical research, which shows that earnings vary directly with education, have a  $\cap$  - shaped relationship with age, are lower for women, and are higher for Jews. The persistent disparities that have been reported may therefore reflect demographic heterogeneity between regions. We investigate this possibility in Table 2.

Table 2 here

Table 2 shows that there is a surprising degree of demographic heterogeneity among wage earners in Israel. There is a 5 year gap between the “oldest” and “youngest” region, and there is almost a 3 year gap between the “least educated” and “most educated” region. There is also substantial regional variation in the proportion wage earners that are women. Finally, because Non-Jews are unequally distributed between the regions there is a large regional variation in the proportion of wage earners that are Non-Jews. The coefficients reported in Table 2 are taken from a log wage equation estimated using micro data for 1995. They indicate a return to schooling of almost 7%, a wage disadvantage to Non-Jews of 6.6% and a wage disadvantage to women of 55%. Applying these coefficients indicates, for example, that earnings in Jerusalem were 8.12% higher than the national average on account of demography while in the North earnings were 14.74% below the national average. The latter is due to the fact that wage earners in the North were relatively young, less educated, and Non-Jewish. On the other hand, they were disproportionately male.

The final column of Table 2 reports the demographically adjusted earnings gap in 1995. This shows that the weighted effect of demographic attributes on monthly earnings can be quite considerable. In the Jerusalem region for example this effect is positive and can account for about 8 percent of the monthly wage (325 NIS). Smaller positive effects are registered for the Haifa, Central, Tel Aviv and Dan regions. Alternatively, in the Northern region, demographic characteristics depress monthly earnings levels by over 485 NIS (some 15 percent).

Amenity theory predicts that earnings should vary inversely with amenities. Table 3 provides data on the regional distribution of certain amenities<sup>11</sup>. With the exception of crime and classrooms, Tel Aviv has the highest amenity endowment and the North the lowest. Amenity theory predicts that earnings should be lowest in Tel Aviv and highest in the North. The fact that the data indicate the converse suggests that the persistent regional disparities that have been reported are most probably inconsistent with Amenity Theory.

Table 3 here

## 5. Conclusions

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<sup>11</sup> We use the coefficient of variation (CV) for earnings to represent earnings opportunities. The greater is CV the greater is the chance of obtaining high earnings relative to the mean.

While the main thrust of this paper has been in the field of measurement we have, *inter alia*, highlighted two other issues pertinent to the regional convergence/divergence debate. The first relates to the importance of considering regional cost of living differences when measuring regional disparities. We have suggested a simple approach to creating regional deflators in the absence of regional consumer price indices. For all its crudeness, this method is nevertheless an improvement on the common practice of side-stepping the issue that characterizes so many studies. The driving force behind regional cost of living differences is house prices, which typically exhibit large differences across regions, and are readily available in most countries. The second issue relates to the significance of our empirical results in the light of ‘amenity theory’. According to this view, the demand for amenities is likely to lower real earnings relative to house prices. This results in amenity-deficient regions having higher earnings growth than amenity-rich regions.

In the realm of measurement, we have applied a new decomposition theorem for mean reverting behavior to analyze the dynamics of regional disparities in real earnings in Israel. It turns out that there is little, if any, mobility in the ranks of the regions over the short run, but there is more mobility over the longer term. The region of Tel Aviv has consistently topped the earnings and house price rankings, while the North and South regions have consistently assumed the bottom two positions. Deflating earnings by house prices causes Tel Aviv to drop one rank and induces a greater measure of equality over time but not in any consistent fashion.

We have applied a new decomposition theorem for mean reversion, which highlights its underlying causes. These are the degree of Gini divergence, the degree of immobility, and the rate of leveling across regions. We have shown that changes in the degree of beta convergence are induced by reinforcing changes in these components. By the same token, stability in the degree of beta convergence may conceal important but offsetting changes in its determining components. We believe that this decomposition clears up much of the confusion surrounding the concept convergence, and is a fruitful way of describing the data.

The results on Gini divergence for real earnings are sensitive to the weights used to calculate regional living cost. Gini convergence in house prices accompanied by an increasing correlation between earnings and house prices implies that earnings adjusted for regional living costs are less divergent than their unadjusted counterparts. This implies that whereas earnings and labor markets induce divergent behavior the opposite applies to housing markets.

Finally, our results conflict with amenity theory in two respects. First, amenity theory predicts that regions that are better endowed with amenities will have lower real earnings. The opposite seems to apply. High amenity areas such as Tel Aviv consistently have high real earnings, while regions that are poorly endowed tend to have low real earnings. Secondly, there is no evidence that the well-endowed areas have lost ground to the less well-endowed areas. Had this been the case there would have been clear evidence of Gini convergence. Such convergence implies that in well-endowed regions, either earnings should have been relatively lower, or house prices should have been relatively higher. The opposite should imply in the poorly-endowed regions. These expectations have not materialized. Since house prices are already relatively high in the well-endowed regions, the failure of amenity theory lies in the labor market rather than the housing market.

It could also be that house prices are too crude an indicator to reflect a concept as nebulous as ‘amenity’ that encompasses many attributes ranging from public services, cultural capital, transportation and feelings of personal security. The latter is a case in point. A speculative reading of our results suggests that a low-amenity region such as Jerusalem (plagued with security issues) should be reflected through higher compensation in real earnings. There is some indication of this trend from our result with Jerusalem picking up over the 1990’s in terms of earnings deflated by local living costs. All this however must remain a matter of conjecture until serious measures of regional amenity are developed.

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**Table 1: Taxonomy of Regional Equilibria**

	K: IMMOBILE L: MOBILE	K: MOBILE L: IMMOBILE	K: MOBILE L: MOBILE
$\frac{W_i}{W_j}$	$\left(\frac{K_i}{K_j}\right)^{\pi_1} \left(\frac{H_i}{H_j}\right)^{-\pi_2}$ $\pi_1 = b^2 \left( \frac{1+c-ad}{b(1+c-d)+1-a} \right)$ $\pi_2 = \frac{b(1-a)}{1-a+bc}$	1	1
$\frac{L_i}{L_j}$	$\left(\frac{K_i}{K_j}\right)^{\pi_3} \left(\frac{H_i}{H_j}\right)^{\pi_4}$ $\pi_3 = \frac{(1-bd)(1-a)}{b(1+c-d)+1-a}$ $\pi_4 = \frac{1-a}{1-a+bc}$	EXOGENOUS	$\frac{H_i}{H_j}$
$\frac{P_{H_i}}{P_{H_j}}$	$\left(\frac{K_i}{K_j}\right)^{\pi_5} \left(\frac{H_i}{H_j}\right)^{-\pi_6}$ $\pi_5 = \frac{\pi_3(1-db)+db}{c+d(1-a)}$ $\pi_6 = \frac{1-\pi_4(1-db)}{c+d(1-a)}$	$\left(\frac{L_i}{H_i} \frac{H_j}{L_j}\right)^{\pi_7}$ $\pi_7 = \frac{1}{c+d(1-a)}$	1

**Table 2: The Effect of Socio-Demographic Attributes on Regional Earning's Differences**

	Age	Years of Schooling	Percent Non-Jewish	Percent Women in Lab. Force	Average Monthly Earnings (NIS) <sup>2</sup>	Weighted Effect on Earnings (NIS)
JERUSALEM	36.67	14.16	1.06%	53.32%	4012	+325
North	35.04	11.31	49.05%	35.77%	3296	-485
Haifa	40.19	13.21	8.95%	47.59%	4207	+293
Sharon	37.55	12.48	13.29%	44.19%	4142	-79
Center	38.47	13.07	3.15%	48.69%	4448	+159
Tel Aviv	37.47	13.15	3.58%	48.79%	4633	+117
Dan	38.66	12.81	1.16%	48.39%	4112	+87
South	37.79	12.41	4.63%	47.74%	3734	-77
<b>Average<sup>1</sup></b>	37.67	12.73	11.98%	46.41%		

1. All variable averages are non-weighted and represent averages for the data set.

2. Estimated on basis of following wage regression:

$$\ln(\text{earnings}) = 5.025 + 0.074\text{Age} - 0.00076 \text{Agesquare} + 0.0694 \text{Years schooling} - 0.0641 \text{Non-Jew} + 0.5527$$

$$\text{Male} + 0.1846\text{Married} - 0.9729\text{Ultra-Orthodox} + 0.088\text{Jerusalem} + 0.1983 \text{Tel Aviv} + 0.412 \text{Haifa} + 0.1241\text{Dan} + 0.1446\text{Center} - 0.0422\text{South} + 0.08491\text{Sharon} + 0.0555\text{North}$$

Source: Household Incomes Survey 1995, Central Bureau of Statistics.

**Table 3: Amenities by Region**

	Culture <sup>1</sup>	<u>HEALTH</u>		Education <sup>4</sup>	Crime <sup>5</sup>	C.V. <sup>6</sup>
		Doctors <sup>2</sup>	Beds <sup>3</sup>			
<b>JERUSALEM</b>	0.61	3.7	5.85	0.208	44.7	0.974
<b>North</b>	0.76	2.5	3.79	0.160	47.6	0.840
<b>Haifa</b>	1.00	3.8	8.67	0.161	64.2	1.160
<b>Center</b>	0.48	4.0	8.48	0.253	73.4	0.920
<b>Tel Aviv</b>	1.92	4.2	6.47	0.0007	73.4	1.199
<b>South</b>	0.76	2.3	3.41	0.152	72.8	0.794

1. Share of cultural performances divided by share of population 1997.  
Source: Annual Report, Culture Authority, Ministry of Education.
2. Doctors per 1,000 population, 2000.  
Source: Department of Health Information, Ministry of Health.
3. Hospital (in-patient) Beds per 1,000 population, 2000.  
Source: Department of Health Information, Ministry of Health.
4. Classrooms per 1,000 population, 2000.  
Source: Local Authorities in Israel, Physical Data, Central Bureau of Statistics.
5. Police files per 1,000 population, 2000.  
Source: Department of Information & Statistics, Israel Police, National Command.
6. Coefficient of Variation of Earnings  
Source: Household Incomes Survey 1999, Central Bureau of Statistics.

Figure 1: Regional Earnings Over Time

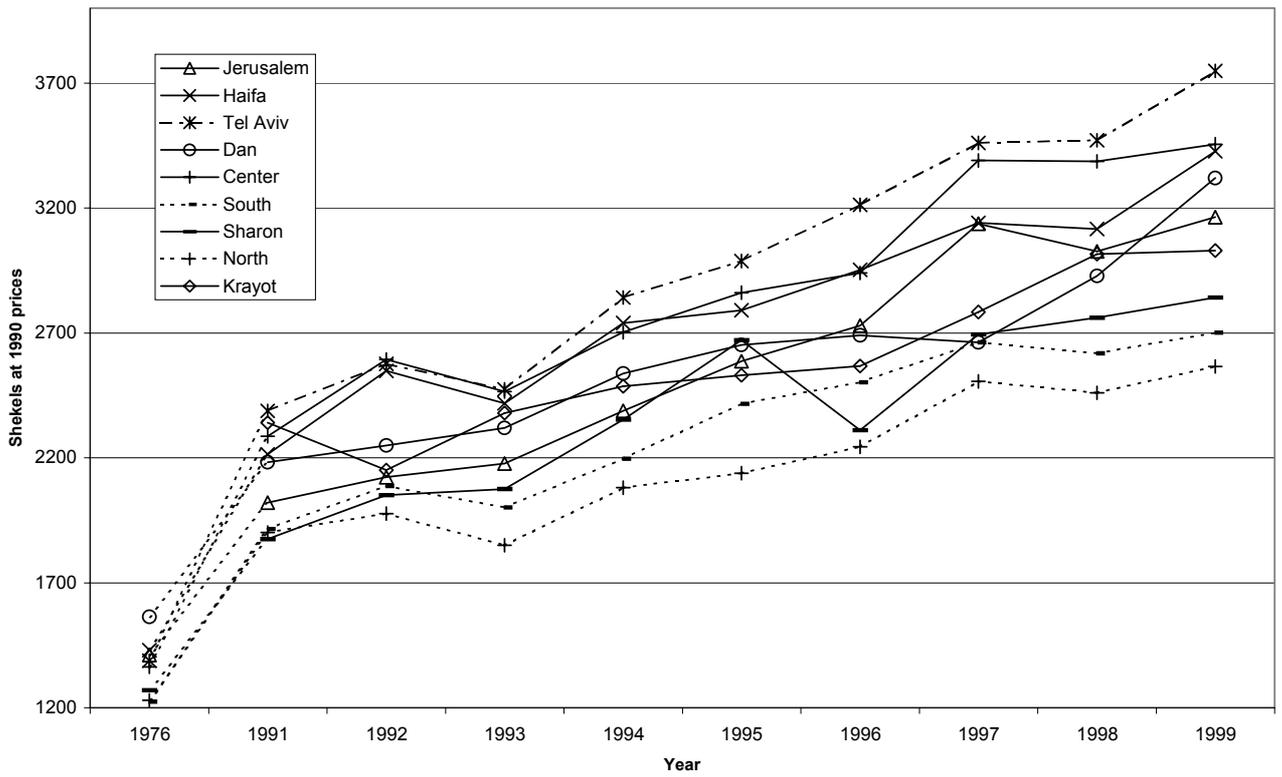


Figure 2: Regional House Prices Over Time

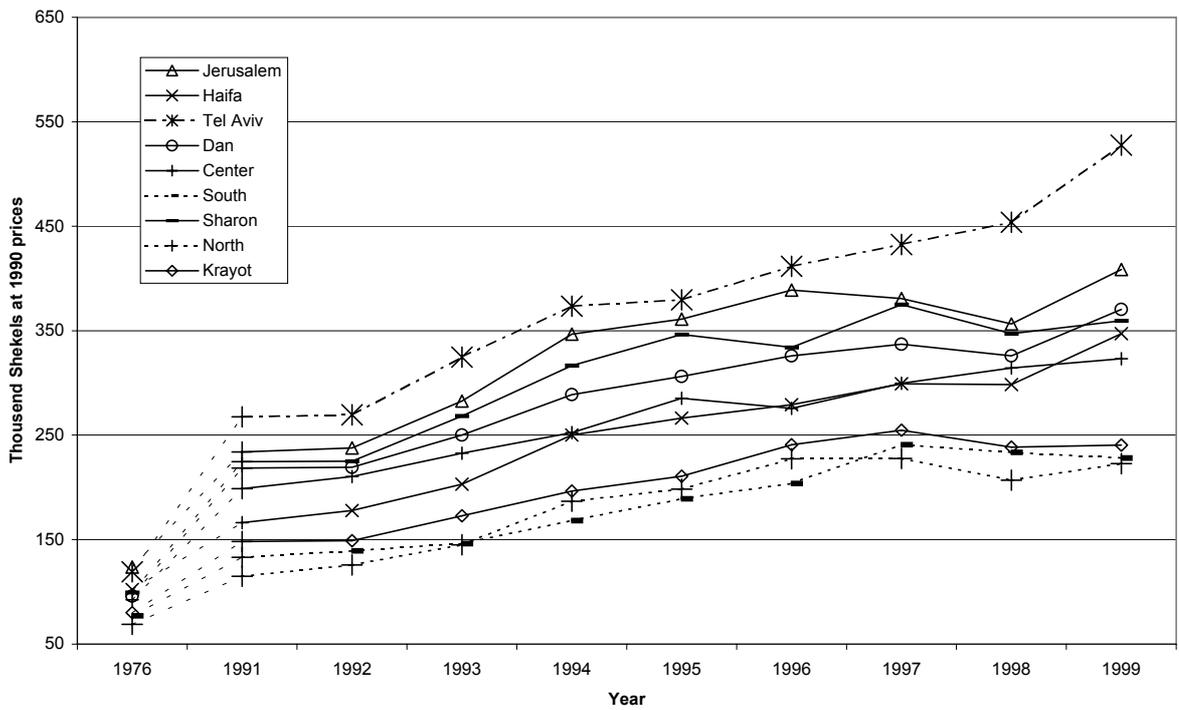


Figure 3: Average Real Earnings Over Time

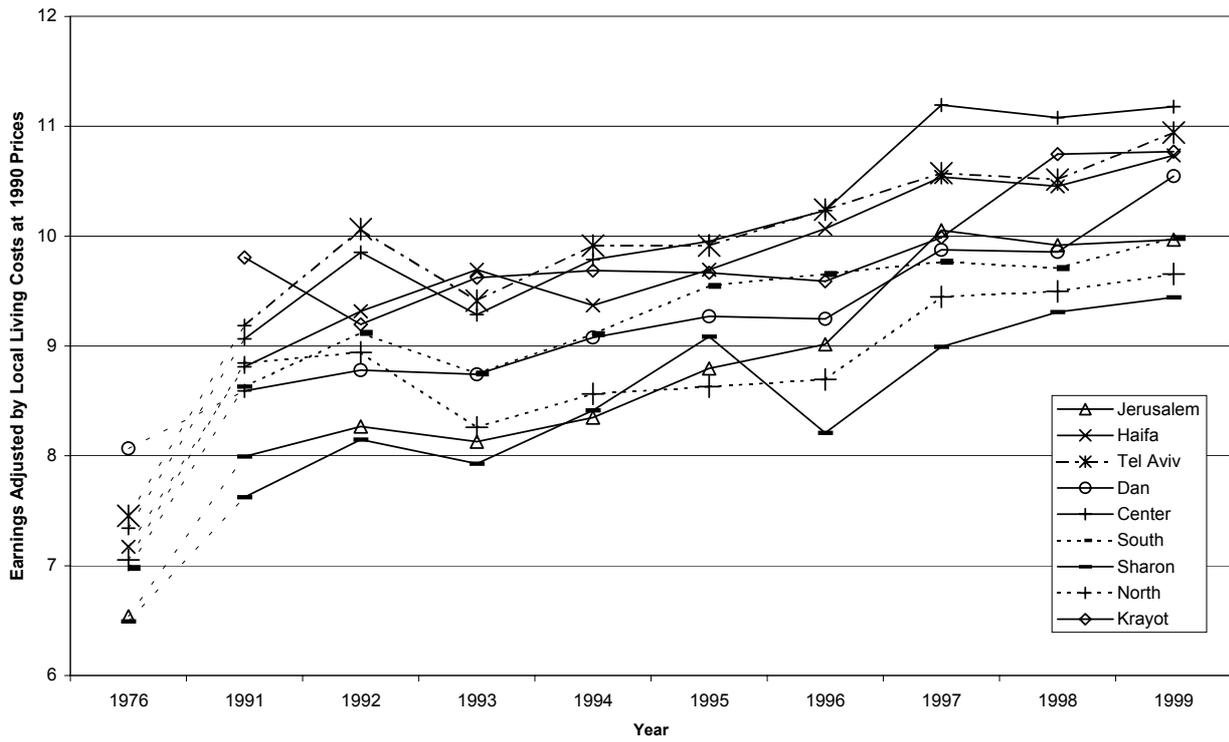


Figure 4: Gini Coefficients for W, P and Y

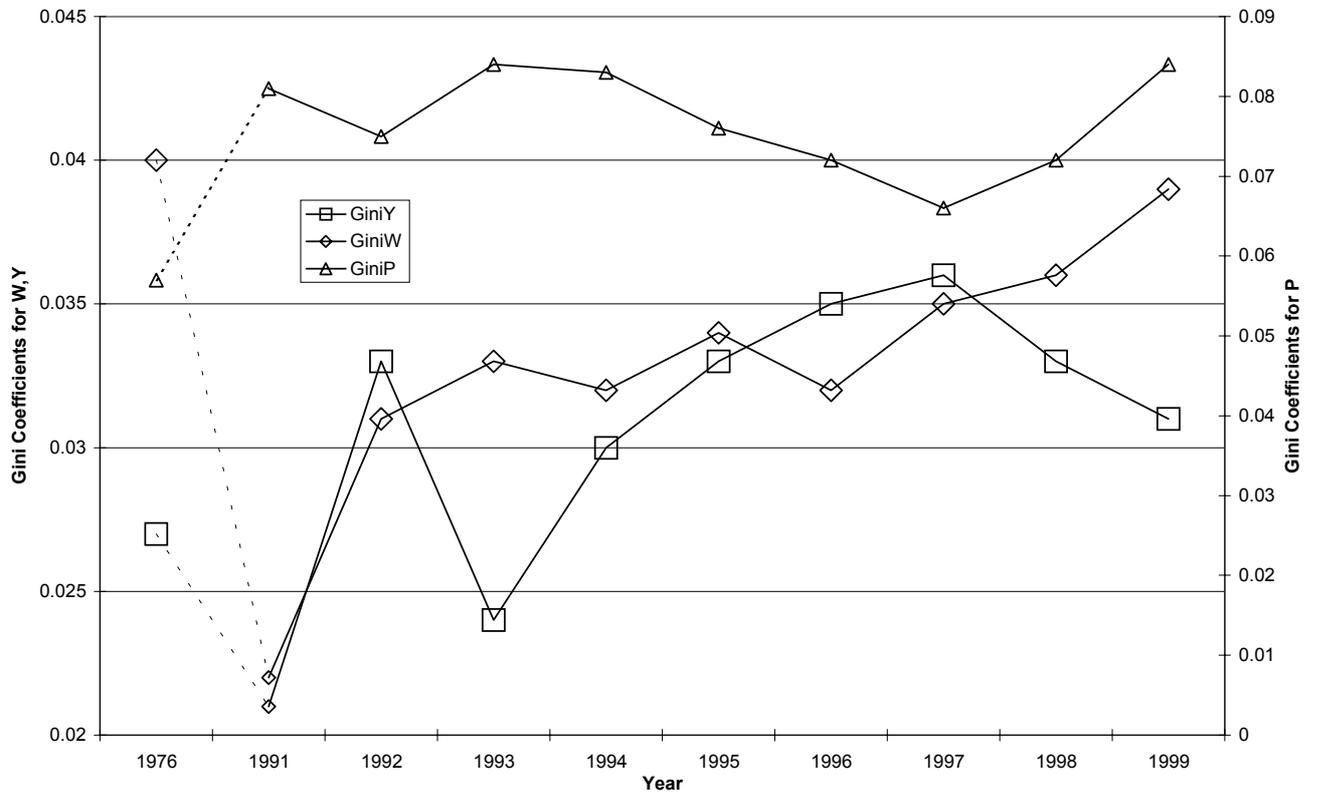


Figure 5: Gini Correlation Between Earnings and House Prices



Figure 6: Gini Mobility Index

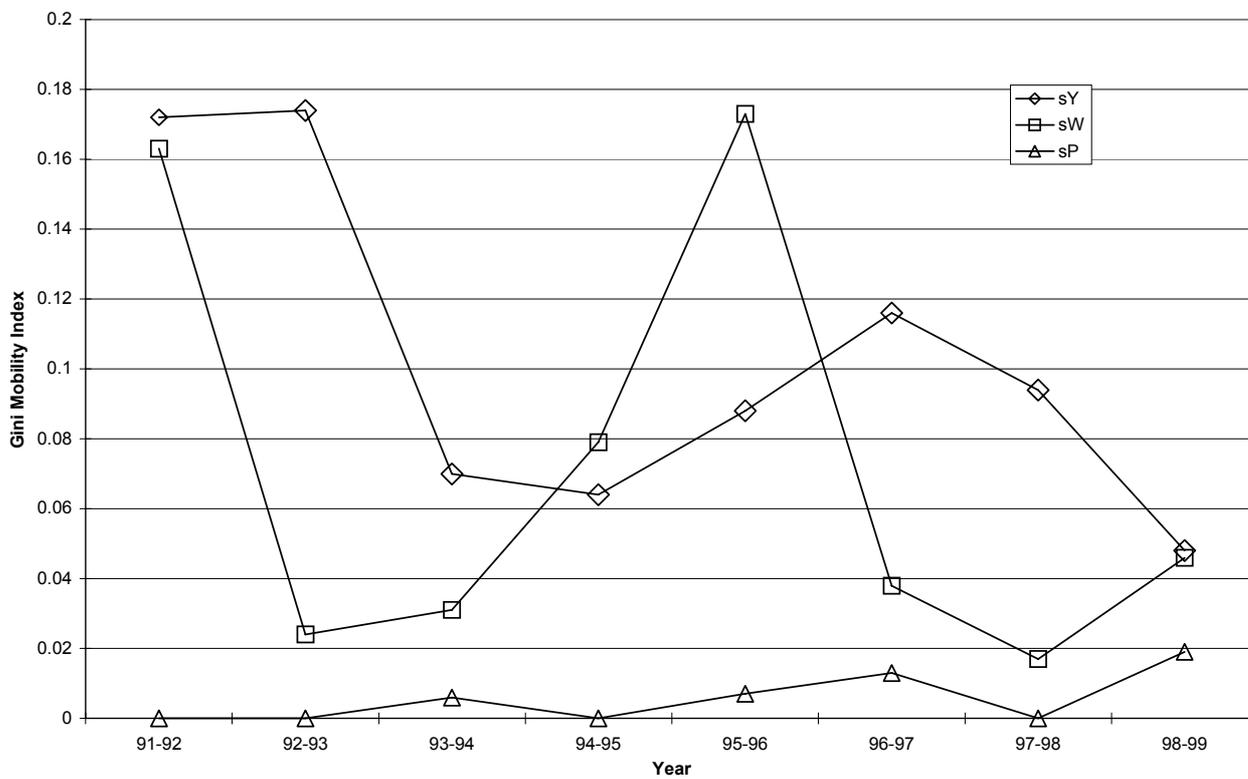


Figure 7: Long-Term Gini Mobility Index

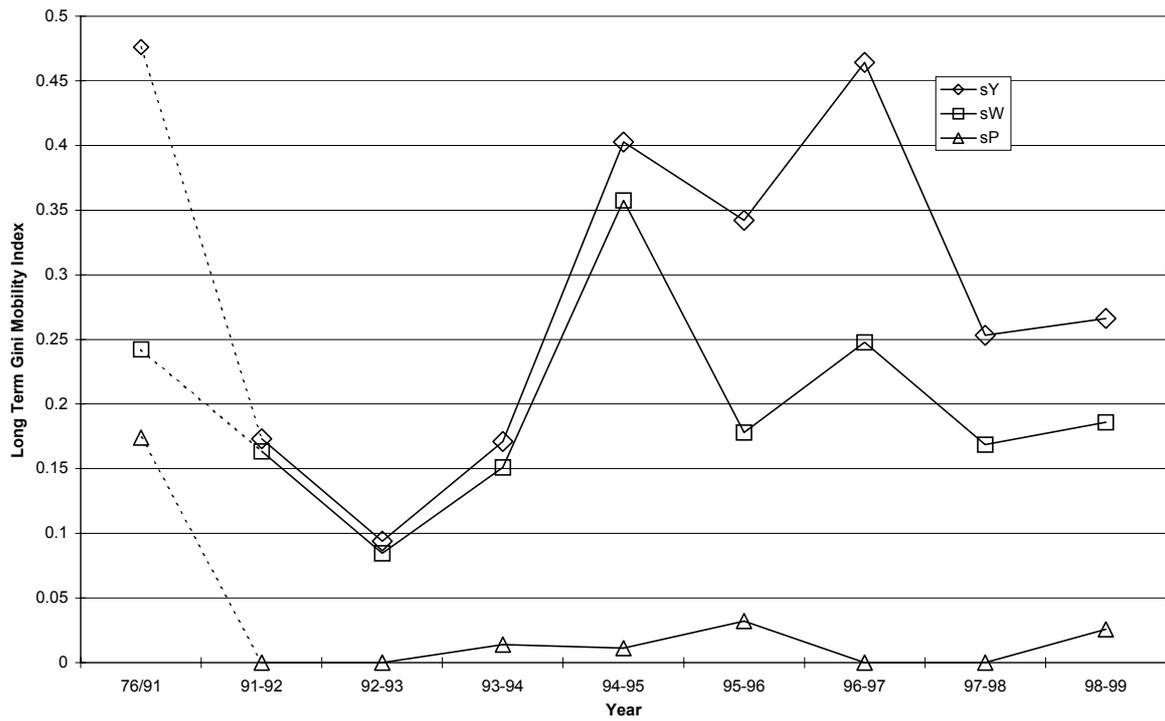


Figure 8: Decomposition of Beta

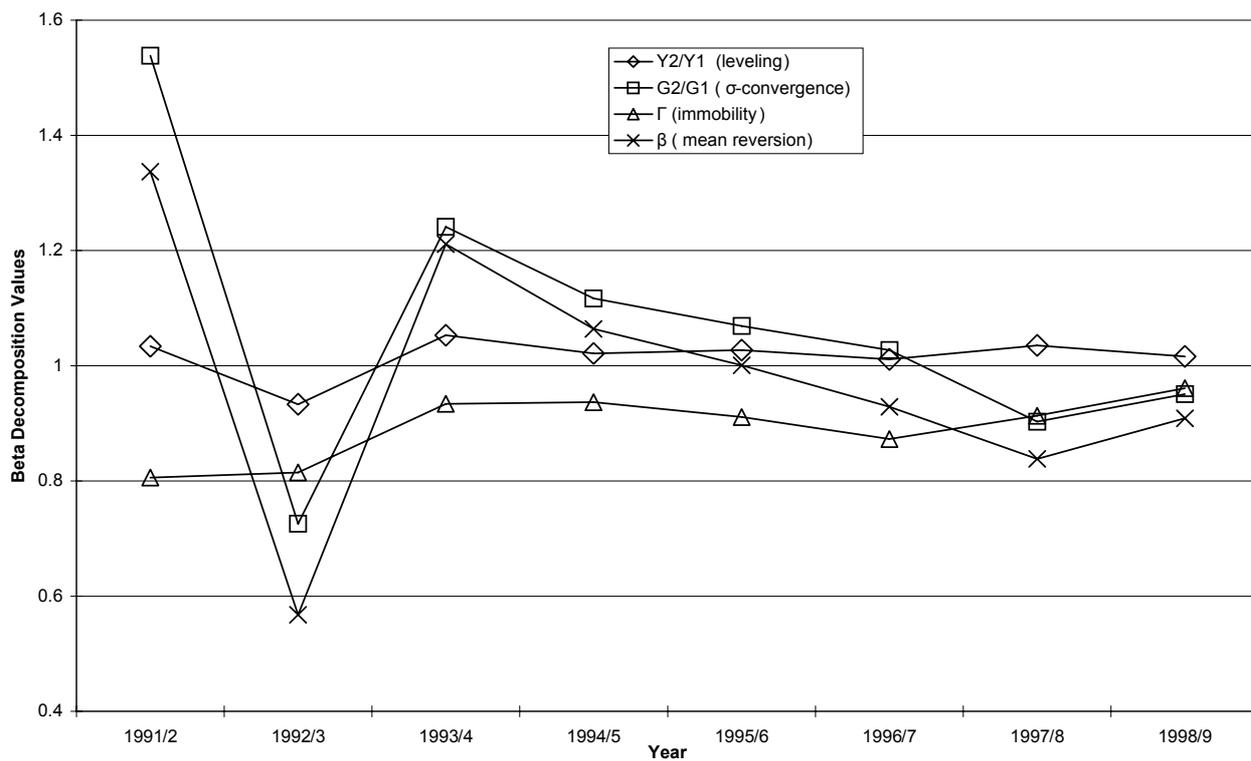
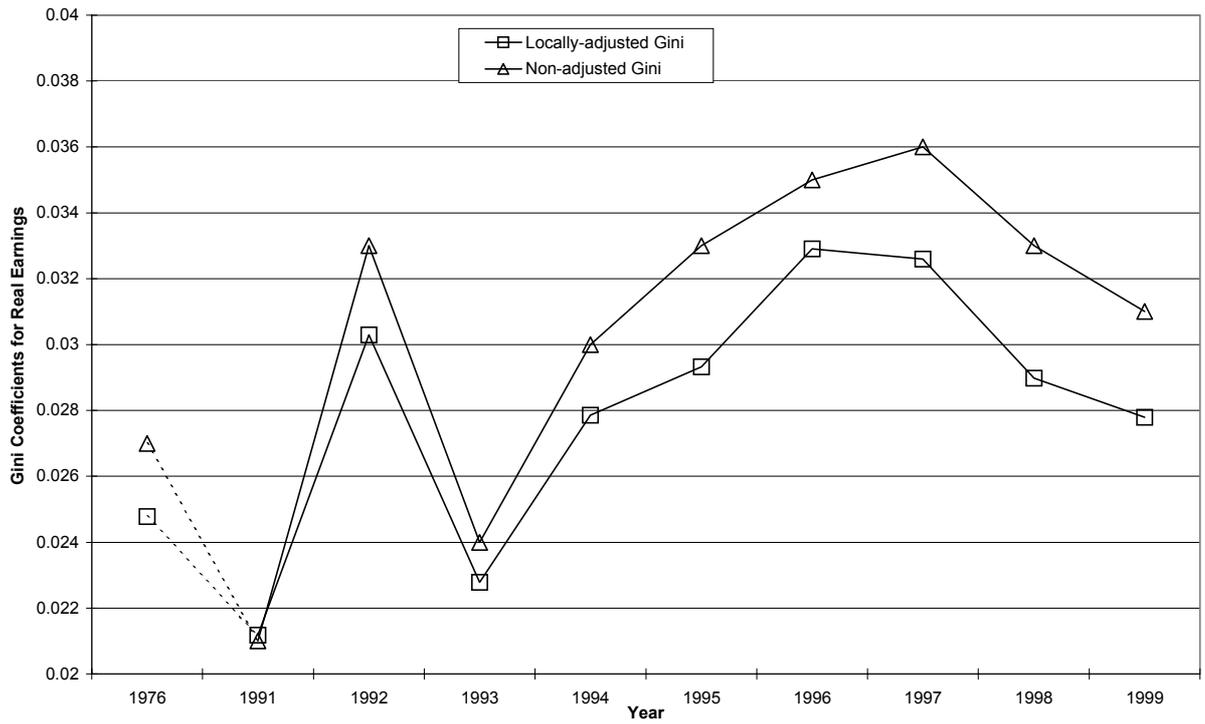
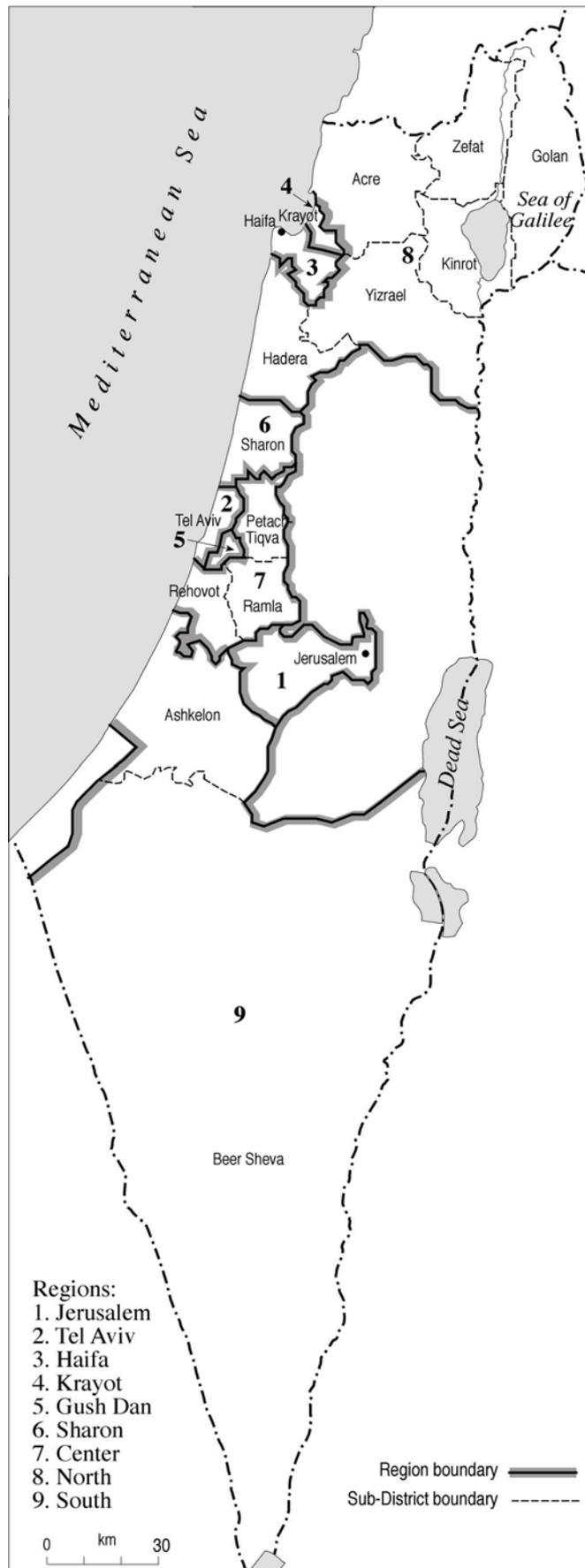


Figure 9: Gini Coefficients: Adjusted and Non-Adjusted for Local Living Costs





Map 1: Geographical Regions of Israel