

# Real Wage Chronologies<sup>1</sup>

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## **Abstract**

We process information in a large number of Canadian wage contracts, signed over a period of several decades, to generate the long-run history of the real wage for each bargaining pair. We term these hitherto unexamined histories ‘chronologies’. We are able to generate 1574 continuous real wage chronologies and we examine the evolution of the real wage in each case. We explore the influence of productivity growth, the labour relations record of the pair, the influence of industry and region as well as the initial wage on the growth of the real wage rate over the decades in the sample. We also consider the relation between the mean and variance of the real wage contained in these chronologies.

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# 1 Introduction

The short-run wage determination process is one of the best-studied areas of economics. The various generations of Phillips Curves and the more recent literature on Wage Curves are efforts in this direction that have produced a wealth of information for a large number of countries. Related to these literatures are efforts which document phenomena that are, at first blush, inconsistent with a narrow interpretation of classical theory and have led to efforts to understand them from new theoretical vantage points. These efforts include papers which deal with industry wage differentials for apparently ‘identical’ workers; these differentials have remained remarkably stable over time and have been documented for a number of countries. Regional effects are also remarkably stable, though these are more obviously consistent with classical notions.<sup>1</sup>

Far less attention has been paid to long-run wage determination processes. Few papers attempt to map and analyse the growth of real wages in particular contexts over several decades.<sup>2</sup> The most likely explanation is the scarcity of appropriate data. National data on real wages are, of course, available. But important puzzles (other than whether real wages across nations converge), such as the existence and persistence of interindustry and regional wage differentials, are intra-national issues. Many panel data which do pro-

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<sup>1</sup>A number of other effects involving firm size, marital status, and gender are also well-established and have also led to fertile discussions and new insights.

<sup>2</sup>An interesting development has been the flowering of the empirical literature on national economic growth and its examination of the important notion of convergence in income per capita across nations. Presumably, income convergence at the national level is associated with real wage convergence as well, particularly within nations and their regions.

vide information at the micro level involve the rotation of individual respondents, thus limiting the period over which their real wages can be studied. In addition, individual mobility across jobs, professions and regions poses other challenges.

Information that relates to the wages paid by firms/institutions to particular *classes* of workers over long periods of time avoids the data problems with *individuals* just noted. For instance, the base wage paid to entry level workers relates to certain job requirements and abstracts from the characteristics of the workers themselves (e.g. their identity, gender, and marital status). Naturally, institutional survival along with the secular stability of job requirements are important issues that must be kept in mind, as is the generality of results that might be claimed from data on particular firms/institutions.

A source of information along these lines derives from the collective bargaining agreements reached between a firm/institution and the union representing a particular group of employees. Data available between 1976 and 2000 on the bargains reached in the Canadian unionised sector make it possible to observe, through this very long period, the history of the real wage agreed upon by each bargaining pair in the sample. We term these real wage histories ‘chronologies’. These chronologies, which have never been examined, provide a unique insight into the history of the real wage level agreed to by a large number of bargaining pairs.<sup>3</sup>

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<sup>3</sup>The studies of Hamermesh (1970) and Sparks and Wilton (1971) pioneered the econometric exploration of US and Canadian collective bargaining agreements (respectively). With time, these explorations became broader and began to cover other provisions of wage contracts such as (i) the incidence and intensity of wage indexation issues, in *inter*

We map the profile of these real wage chronologies over several decades and thousands of wage contracts and ask a number of questions. What do these wage profiles look like? Do these chronologies reflect the interindustry and regional wage patterns that have been noted in earlier literatures? Conditioning on industry and regional effects, is there any evidence of convergence through time in these wage rates? Do these chronologies reflect the secular productivity growth of the sector from which they derive? Does recent attention to the labour relations environment<sup>4</sup> within which the wage agreements were reached seem warranted? Can any relationship between *inter alia* Ehrenberg, Danziger and San (1983, 1984), Card (1983, 1986), and Hendricks and Kahn (1983) and (ii) the duration of wage contracts, in *inter alia* Murphy (1992, 2000). These are but a few examples of papers that deal with the major provisions of contracts, some addressing several features at the same time and others venturing into further points of interest - e.g. Hendricks and Kahn (1986), Fortin (1996), Gu and Kuhn (1998), and Danziger and Neuman (2005).

These studies have not exploited the entire history of the collective bargaining agreements reached by a pair (a firm and a particular union). The concepts of unexpected and uncompensated inflation require that contracts be connected so that information from the previous contract can be allowed to influence the terms of the current agreement - see Christofides (1987). However, these connections are between consecutive contracts only. Also, the examination of a possible wage ‘explosion’ in the aftermath of wage controls relied on linking contracts under controls with those signed by the same pair in the aftermath of controls - see Christofides and Wilton (1985). Finally, the papers on holdout pay attention to the issue of timing between contracts. However, *the entire contractual history* for each pair can be linked together and the length of these chronologies is limited only by the available sample length and by possible breaks in the relationship between pairs.

<sup>4</sup>See Blanchard and Philippon (2004), Park (2007), Aghion, Algan and Cahuc (2008) and references therein.

moments of the real wage chronologies, which might suggest that high real wage variability must be compensated for, be discerned? We deal with these questions, taking into account the possible endogeneity of the initial wage needed to examine convergence through a uniquely appropriate instrument.

Real wages are surprisingly flat over the entire period studied. We find industry and regional patterns in the chronologies that conform with those apparent in short run wage determination studies. Also at odds with narrow classical notions is the apparent dependence of real wages on productivity growth in the sector (as distinct from economy wide growth) and the industrial relations record of the pair. On the other hand, conditioning on industry, regional effects and other variables, the evidence for convergence is strong, suggesting that important arbitrage processes are at play in the long run. Looking within these real wage chronologies, it appears that chronologies involving a high average value also tend to have a high variance of the real wage rate. We note that chronologies could also be used to analyse other labour market outcomes (e.g. indexation incidence and strength, as well as contract duration) but such tasks are beyond the scope of the current paper.

In section 2, the data used and the concept of a real wage chronology, as it derives from the contract data, are discussed; features of the derived chronologies are also examined. In section 3, the method used to examine these chronologies econometrically is presented and the results obtained are discussed in section 4. Conclusions appear in section 5.

## 2 Contract Data and the Wage Chronologies

The contract data used for this study are constructed from electronic records provided by Human Resources Development Canada (HRDC), as it was known when the data were released to us. The data base contains information on 11885 contracts signed between 1976 and 2000 by firms which employ 500 or more employees. Each contract contains a unique identifier which allows us to string together all agreements signed by the same pair. In order to ensure the continuity needed in the chronologies, only contracts with an uninterrupted history are included in the analysis, leaving 8928 contracts available for analysis - construction contracts are also excluded because they were not part of the data until 1984. The HRDC data contain information on a number of variables, including the settlement, effective and expiry dates of the contract, the number of employees that it covers, the industry and region that it is located in, and the nominal base wage (including ‘fold-ins’ generated by the cost of living allowance clause (COLA) if any) at the end of the previous contract  $pexpwage$ . Information in the current contract makes it possible to generate the annual nominal wage percentage change (including COLA generated increases)  $\dot{w}$  and the duration of the contract measured as the difference between the expiry date and the effective date of the current contract,  $Duration$ , in months. The nominal wage level at the expiry date of the current contract may then be calculated as  $expwage = pexpwage + (pexpwage \times (\dot{w}/100) \times (Duration/12))$ .

The nominal wage rates  $pexpwage$  and  $expwage$  are converted into real terms using the values of the consumer price index at the expiry date of the previous contract (in most cases this is equal to the effective date of the

current contract) and the expiry date of the current contract. Thus, the real wage level at the beginning and at the end of each contract are calculated in this way. Descriptive statistics on the variables used, by contract, are presented in Table 1. Duration is shown to have a mean of 25.41 months and a standard deviation of 11.62 months. The average nominal wage at the end of previous contracts is \$12.66 with a standard deviation of \$4.55; at the end of contracts, the average nominal wage is slightly higher at \$13.69 with a standard deviation of \$4.57. The average real wage at the expiry date of previous and current contracts is 15.13 and 15.24 respectively with standard deviations of 3.99 and 4.00 respectively. The average annual increase in the overall (including COLA) nominal wage rate is 4.85% with a standard deviation of 4.26. Figure 1 shows the real hourly contract wage calculated over all contracts whose effective date falls in a particular year. For comparison purposes, Figure 1 also shows real hourly earnings<sup>5</sup> from 1983 to 2000 - the period over which the latter series is available. The contract real wage series is higher and more volatile, especially during the 1990s - we return later to the issue of whether volatility needs to be compensated for. The relative position of the two series is not surprising given that contract wages come from large firms in the unionized sector. The greater volatility of the contract series reflects the turbulent period of industrial relations in the public (provincial and federal) sector during the period 1991 -1996, a period during which active wage control policies were pursued. In addition, the contract series is more likely to reflect idiosyncratic forces which average out in the

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<sup>5</sup>Hourly earnings are the CANSIM montly series V255025. They have been converted into real terms using the CPI index (P100000) and have been averaged by year.



aggregate. Both series in Figure 1 show the remarkable stability in the unconditional real wage through time. In general, there has been no perceptible real wage growth over this period and, indeed, both series are below their starting values by the end of the period. One issue that is explored below is whether productivity gains have influenced wage growth at the pair level during this period.

The HRDC data base includes a regional identification code and 3-digit SIC code which allow us to create seven regional dummy variables (Atlantic, Quebec, Ontario, Prairie, British Columbia, Territories and Multi-province<sup>6</sup>) and ten industrial dummy variables (Natural Resources, Manufacturing, Transportation, Communication, Utilities, Trade, Education, Health, Services and Others) that categorize each contract. Table 1 shows that most contracts are in Education (27%), followed by Manufacturing (20%), and in Ontario (35%). Figures 2 and 3 show the hourly real contract wage calculated over all contracts, whose effective date falls in a particular year, by SIC (Figure 2) and by region (Figure 3). As in the case of Figure 1, a striking feature of Figures 2 and 3 is the remarkable flatness of the series for each industry and region. However, more features of interest are apparent at the industry and regional levels. In Figure 2, remarkably stable inter-industry wage differentials are apparent over this two-decade period. Services generally have the lowest real wage while contracts in Education, Natural Resources, Transportation and Manufacturing tend to have the highest real wages. This ranking is consistent with the one in data from the 1986 Labour Market Activity Survey of Canada established by Gera and Grenier (1994).<sup>7</sup> Figure 3

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<sup>6</sup>Certain contracts cover more than one province and are thus multi-regional.

<sup>7</sup>There is a widespread view that industry effects, which are significant in individual

shows similar information to that in Figure 2 but on a regional basis. Contracts in the Atlantic provinces have the lowest real wages during most of this period while contracts in British Columbia and Ontario have the highest real wages - note that a common price index has been used to deflate across regions. Again, this ranking is consistent with stylized facts about regional disparities in Canada over the period studied. In the empirical work below we take into account possible industry and region effects. There is slight visual evidence of some convergence in the series of Figure 3, a general issue to which we return below.

One contribution of this paper is arranging the contract data into pair-based chronologies. This is achieved by sorting the contracts using the unique identifier for each pair. Overall, 1574 unique chronologies can be created. The longest chronology involves as many as 19 renewals and spans a horizon of 24 years. As an example, Figure 4 presents the 17 longest real wage chronologies in Manufacturing. Each line shows the real wage history embodied in the contracts signed by a particular pair. For instance, the top wage functions, cannot be easily explained by classical competitive theories of wage determination (see Slichter (1950), Thurow (1976), Wachtel and Betsey (1972) and Cain (1976)). Studies of wage determination based on human capital and mobility frictions typically leave substantial unexplained inter-industry or inter-firm wage differentials - see Dickens and Katz (1987) and Krueger and Summers (1988). Helwege (1992) shows that those differentials are not highly positively correlated with subsequent employment growth, as one could expect if they resulted from mobility frictions. Gibbons and Katz (1992) investigate the possibility that differentials are explained by unmeasured ability differences but do not have encouraging results. The more recent study by Walsh (1999) shows that the efficiency wage model can only explain a small fraction of the wage differentials that prevail across industries.

line joining the circles shows that this particular pair agreed to the highest sequence of real wages among all the chronologies shown. The first dot shows the beginning-of-contract (i.e. *pexpwage*) real wage for a one-year agreement that became effective in 1979 and the next dot its end-of-contract real wage (i.e. *expwage*); the latter is higher than the former, indicating that there was real wage growth during this contract. The end-of-contract real wage is also the (prior to the) beginning-of-contract wage for the next agreement which became effective in 1980 and lasted until 1983. This second contract entailed a reduction in the real wage rate. This may have occurred despite increases in the nominal wage rate if, as was likely, inflation was unexpectedly strong during this period. The third contract in the sequence began in 1983; it was a two-year contract, and did entail real wage growth. The particular chronology discussed shows the changing pattern of contract duration for the pair involved and follows a slight upward trajectory. This is generally true of the other chronologies shown in Figure 4. There is considerable difference in the real wages paid by the top and bottom chronologies; in the case of Figure 4, this difference is more than ten real dollars per hour. This is noteworthy given that, in both cases, the real wage shown is the base wage for firms in manufacturing, albeit not necessarily firms of the same size and not necessarily paid to workers with similar skills who are represented by the same unions. It should be noted that a smaller difference remains even if we confine Figure 4 to Ontario, thereby reducing (but not eliminating) regional disparities.

A final feature of Figure 4 is that not all chronologies begin or end at the same time. For some purposes, it is useful to have common starting

and ending points for these chronologies. For instance, any discussion of the influence of the initial wage and convergence would be facilitated if this condition were satisfied. With this in mind, we selected a fixed window of 22 years, from 1980 to 2001, and discarded the modest amount of information outside this window. When a chronology is incomplete, either at the start or at the end of the window, we use information in the extant chronology to complete it. More precisely, we calculate the average annual growth rate ‘Grate’  $Grate_i = ( \ln w_{T_i} - \ln w_{0_i} ) / T$  over the entire extant chronology of length  $T$  and use this to compute the starting (1980) level of the real wage;  $w_{T_i}$  indicates the expiry wage *expwage* at the end of the last contract and  $w_{0_i}$  the initial wage *pepwage* at the beginning of the first contract in the chronology. The resulting information is used in Figure 5 to illustrate how the values of Grate in the 387 chronologies in Manufacturing relate to the logarithm of the initial wage in the respective chronology. A negative relationship, statistically significant at the 1% level, is suggested - figures in brackets are  $t$ -statistics. We return to this issue in the empirical section below.

Table 2 shows descriptive statistics on important variables based on the set of 1574 chronologies. The average value of Grate is 0.0032, suggesting that the very flat profile of the illustrative chronologies in Figure 4 is more broadly representative. The standard deviation of Grate is 0.0136. The average value of the real wage rate *at the start* of the historical chronologies is 14.43 real

dollars<sup>8</sup> with a standard deviation of 3.94. When the historical chronologies are completed back to 1980 (where this is necessary), the average value of the real wage in 1980 is 14.62 with a standard deviation of 4.7.<sup>9</sup> The closeness of the figures in rows 2 and 3 of Table 2 suggests that the historical and completed chronologies are not very different. This, despite the fact that the completed average length of the chronologies over this window is 12.01 years. The number of renewals in the historical chronologies is, on average, 5.67 with a standard deviation of 3.93. Regarding industries and regions, 25 percent of all chronologies are from the manufacturing sector and 33 percent of them are from Ontario.

A variable that has an important long-run role in the wage determination process is aggregate productivity growth. The impact of aggregate productivity growth at the micro level is typically hard to discern empirically. The variable ‘Prod’ is defined at the sectoral level instead as the annual growth rate of an index of labour productivity over the length of each historical chronology. It was generated from Statistics Canada Table 383-0005 and was attached to the HRDC database using the three-digit SIC code and the effective date of the contract. Prod has a mean of 0.0171 and a standard deviation of 0.0183 over the chronologies in the sample - Table 2. In classical

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<sup>8</sup>Note that this number is lower than the figure of 15.13 real dollars reported, in the contract-based Table 1, as the average real wage at the expiry of the previous contract because it is calculated at an earlier point in time.

<sup>9</sup>The fact that the 1980 average real wage of the completed chronologies exceeds the average real wage at the start of chronologies (row, 3 versus row 2 in Table 2) suggests that the real wage chronologies that have had to be projected back to 1980 entailed higher than average real wages and/or lower Grates.

terms, productivity growth at the sectoral level (unlike its aggregate counterpart) should have no lasting effect on the real wage rate in the sector. We examine whether *Prod* is a significant statistical force at the individual chronology level.

Another variable that may condition real wage outcomes in the long run is the professionalism and effectiveness of the labour relations practices followed by the bargaining pair.<sup>10</sup> These practices are not exercised in a vacuum but, rather, reflect the economic environment that the pair operates within. A variable that may capture both aspects is the duration of negotiations between the pair (*Durneg*) leading up to the contracts that make up the chronologies. In the HRDC data, this variable is measured as the length of time between the official notice to bargain and the settlement date for the contract. It has a mean of 8.18 months and a standard deviation of 4.37 months - Table 2. In a number of games, the pie gets smaller with delays in reaching agreement. In this spirit, we take account of *Durneg* in the empirical work below.

We also report, in rows 2 and 4 of Table 3, an alternative initial real wage and the average value of the duration of negotiations in the previous contract *Pdurneg*. These variables are used to deal with possible endogeneities in the regression analysis that follows - see the next section. For the moment, we note that, though they are independent of current-contract notions, they

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<sup>10</sup>Blanchard and Philippon (2004) consider the links between the ‘quality of labor relations’, the speed of learning by unions and the effects on unemployment of economic shocks. They provide an aggregative model that clarifies these links and some cross-country empirical evidence that is consistent with their existence. For a political economy treatment, see Aghion, Algan and Cahuc (2008). See also Park (2007).

are close (in terms of descriptive statistics) to the variables that they will instrument.

### 3 Methodology

Having introduced the concept of the wage chronology and having traced out 1574 such chronologies in various industries and regions, we turn to an econometric analysis of the determinants of the annual rate of real wage growth, *Grate*, implied in each chronology. As already noted, this rate is established for each chronology over its life. We control for industry and region effects but also explore the influence of the other variables mentioned above, namely the average (over the chronology) annual rate of sectoral productivity growth *Prod* and the average (over the chronology) duration of negotiations embarked on by the pair *Durneg*. When the influence of the initial real wage is also taken into account, this wage is normalized at its 1980 value. In the case of incomplete chronologies, *Grate* is used to project the earliest available real wage backwards to 1980 and, in light of this, *Grate* remains the appropriate regressand.

The forces of wage arbitrage and convergence would imply a negative relation between *Grate* and the initial real wage  $\ln W_0$ . However, measurement of this process could be complicated by unobservables. If, for example, management quality is such that *Grate* defined over the entire chronology is (say) unusually low, this may imply low wages and an initial wage that may also be unusually low. Thus, the initial wage when it is included as a regressor may be positively correlated with the equation error term; if so,

the estimator of the coefficient on  $\ln W_0$  will be biased. In order to avoid this possibility, we instrument (using Two Stage Least Squares) the initial 1980 wage for each chronology using a relevant average of starting wages which *excludes the own wage* for each particular chronology. This average is calculated at the detailed three-digit industry level (rather than the more aggregate level used in the regressions) and for the province (rather than the more aggregate region used in the regressions) within which each particular chronology is located - see row 4, Table 2. Its natural logarithm is used to instrument the natural logarithm of the initial real wage  $\ln W_0$ .

A similar complication may arise with respect to *Durneg*. If, for instance, large settlements that are due to unobservables take longer to negotiate, then the error term may be positively related to *Durneg*, leading to bias in the estimation of its coefficient. The potential problem here may not be severe: An unobservable that makes for a high wage settlement may not always involve long negotiations if it is acknowledged by both sides of the bargain. In addition, in the regressions that follow, *Durneg* is defined as an average over all the contracts signed by the pair in each chronology, thereby weakening the endogeneity mechanism. Nevertheless, we explore two robustness checks: First, we proxy the industrial relations context within which the bargaining pair works with the previous-contract duration of negotiations (*Pdurneg*), see row 8, Table 2 for descriptive statistics. In an alternative approach, we treat *Pdurneg* as an instrument, in which case the predicted values for *Durneg* and  $\ln W_0$  in Two-Stage-Least Squares are constructed from all exogenous variables as well as the two instruments. These specifications are explored in the appendix Table A1. All estimation is carried out with SAS.



In order to generate the mean and variance of the real wage rate within each chronology, it is necessary to confine our attention to sequences that entail more than one contract. Given that, we generate the sample mean and standard deviation of the real wage rate prevailing at the start of the contract (the end of the previous contract) using *perpwage*.

In all cases, the average number of employees in each chronology is used to weight the data for each chronology. For this reason we are unable to comment explicitly on the firm size effect.

## 4 Empirical Results

Table 3 contains estimates obtained. Results I-III refer to weighted OLS regressions where the possible endogeneity of  $\ln W_0$  is not taken into account. Result I reports the regression of *Grate* on an intercept, *Prod* and *Durneg* only. *Prod* has the expected positive coefficient and it is significantly different from zero at the 1% level. *Durneg* has a negative coefficient which is significantly different from zero at the 1% level. When the logarithm of the initial wage is added, in Result II, the estimates on the coefficients of *Prod* and *Durneg* are not substantially altered and the initial wage has a negative coefficient which is significantly different from zero at the 1% level. The negative coefficient suggests some degree of convergence in that chronologies with large values of their initial 1980 real wage tend to be associated with low values of *Grate*. Industry effects (Manufacturing is the omitted class) and region effects (Multi-province contracts are the omitted class) are added in Result III. The coefficients for these effects are generally signifi-

cantly different from zero at the 1% level. The estimated industry effects are consistent with the location of the profiles in Figure 2 and the results in Gera and Grenier (1994). This suggests that the stylized facts on inter-industry differentials apply to base wage rates as well and, indeed (given that the regressand is wage growth), the stylized facts may become stronger through time. The estimated region effects are consistent with generally held views on regional income differences and growth patterns during this period; for instance, realizing that comparisons are made indirectly through the omitted class of multi-province chronologies, Ontario chronologies have relatively high growth and those in the Atlantic provinces, Quebec and the Prairies relatively low growth, suggesting that regional differences in base wage rates may increase. We note, however, that the estimated industry and region effects (which are intercept shifts on  $\ln W_0$ ) are considerably smaller than the coefficient on  $\ln W_0$ .

The instrumental variable estimates appear in Results IV and V. Result IV, which excludes the industry and region effects, is quite similar to Result II, the main difference being the reduced  $t$  value for the coefficient on the instrumented initial wage, which nevertheless continues (at -10.56) to indicate that the logarithm of the initial wage has a coefficient which is significantly different from zero at the 1% level. Result V is analogous to Result III and generally similar except that chronologies in the Atlantic, Quebec and Prairie regions do not now have significantly lower growth than chronologies involving multi-region contracts. A Hausman (1978) specification test accepts equality between the OLS and IV estimates and, indeed, the coefficient estimates in Results III and V are very close.

Using the estimates in Result V, it is worth considering the quantitative importance of the estimates for the explanatory variables *Prod*, *Durneg* and  $\ln W_0$ . An increase in *Prod* by one standard deviation (0.0183 in Table 2) would have the effect of increasing *Grate* by 0.000926 ( $0.0506 \times 0.0183$ ). This is approximately 29% of the mean value of *Grate* (0.0032) in Table 2. While this is not an enormous effect, it is not negligible. Thus, the average annual productivity growth experienced over a chronology does have a measurable effect on the average annual growth rate of real wages over a chronology. An increase in *Durneg* by one standard deviation (4.37 in Table 2) would decrease *Grate* by 0.000874 ( $-0.0002 \times 4.37$ ), an effect comparable to that of an increase in *Prod* by one standard deviation. Thus, the ability of the pair to work effectively at the bargaining table does appear to have an impact on the real wage fortunes of the pair. Finally, an increase in  $\ln W_0$  by one standard deviation (0.25 in Table 2) would decrease *Grate* by 0.00455 ( $-0.0182 \times 0.25$ ). This suggests, relative to the productivity effects, substantial effects through the convergence processes. The effects of the convergence calculations are about five times as large as those for productivity.

While the economic case for the endogeneity of *Durneg* is not overwhelming, it is important to examine whether the conclusions reached above are robust to the procedures outlined in the previous section. In general, these robustness checks are favourable and we, therefore, confine their detailed presentation to an appendix. Note that a Hausman (1978) specification test accepts the equality of the OLS and IV estimates. Table A1 reports details of these checks. In the first regression, the variable *Durneg* is replaced by *Pdurneg*. The estimated coefficient (-0.0004) is equal to that reported as

Result I in Table 3. When the instrumented version of  $\ln W_0$  is added to *Prod* and *Pdurneg*, the estimated coefficient ( $t$  value) is, at -0.0157 (-10.21) very similar to Result IV in Table 3. This is also true when industry and region effects are included (columns 5 and 6, Table A1). In the alternative robustness check, *Pdurneg* is also used as an instrument for  $\ln W_0$  as well as *Durneg* (columns 7 to 12, Table A1). In column 7, Table A1, the estimate for the coefficient on *Durneg* is higher and that for *Prod* lower than in column 1, Table A1. However, this difference disappears in the more complete specifications: In the most complete specification (columns 11 and 12, Table A1) *Durneg* entails a coefficient (-0.0002) which is identical to that in column 9, Table 3, albeit with a  $t$  value which, at -1.97, indicates significance at the 5% but not the 1% level. The coefficients on *Prod* and  $\ln W_0$  continue to have the expected signs and be significant at the 5% level but they are somewhat lower in absolute values relative to those in column 9, Table 3. Thus, the calculations for their quantitative significance discussed above may present maximal impacts. Industry effects in these regressions are not much affected, though the regional effects display two noteworthy changes, namely the now (relative to Result V, in Table 3) significantly lower growth in real wages in Quebec and British Columbia relative to multi-province chronologies.

The regressions of the mean value of the real wage on the variance of each chronology are carried out as follows. In order to construct the mean and variance within each chronology, at least two contracts are needed. We have 1291 chronologies for which that is true. We have 1114, 955, 845, 738, 648, 540, 381, 282 and 224 chronologies for which we have 3, 4, 5, 6, 7, 8, 9, 10 and 11 contract renewals respectively. For each of these samples, we

run the regression of the chronology mean on the chronology variance with and without industry and regional effects. The coefficients ( $t$  statistics) on the variance in these ten regressions are: 0.37 (5.46), 0.34 (4.8), 0.42 (6.06), 0.42 (5.94), 0.47 (6.45), 0.46 (6.00), 0.43 (5.50), 0.43 (3.74), 0.40 (2.98) and 0.08 (0.39) when the industry and region effects are present. The results when the industry and region effects are omitted are very similar, with both the estimated coefficients and  $t$  statistics being somewhat higher. Note that, when 10 contract renewals are present, the sample size is too small to support any useful statistical analysis. Full results are available on request.

These estimates point to a positive association between the real wage mean and the variance, suggesting a compensating differential (high real wage risk employment requiring a higher average real wage).<sup>11</sup> The size of this differential seems substantial. The average level and the sample standard deviation of the variance is 0.77 and 1.375, respectively, in the sample of 1291 chronologies with two contract renewals and these numbers grow to 1.111 and 1.919, respectively, in the sample of 282 chronologies with ten contract renewals. The average real wage for these two samples is \$15.02 and \$15.75 respectively. An increase in the value of the explanatory variable by one standard deviation in the sample of 1291 chronologies will increase the real wage by \$0.51 ( $1.375 \times 0.37$ ) on a real wage base of \$15.02, or 3.4%. A similar calculation for the sample of 282 chronologies will increase the real wage by

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<sup>11</sup>Naturally, full indexation against the price level would smooth the real wage with respect to inflation but not necessarily with respect to other shocks. Including an indicator of how many contracts in the chronology have a cost of living allowance clause produces coefficients which are not significantly different from zero on a consistent basis and do not alter the estimates for the coefficient on the variance of the real wage.

\$0.77 ( $1.919 \times 0.40$ ) on a real wage base of \$15.75, or 4.8%.

The analysis in the previous paragraphs exploits the characteristics of the contracts involved in these chronologies. Such information is not readily available in other sources. We note that the history of other characteristics (e.g. contract duration and indexation incidence and intensity) could also be examined using the methodology involved in these chronologies. However, such explorations are beyond the scope of the current paper.

## 5 Conclusion

In this paper, we take a fresh look at the information contained in the repeated wage agreements struck by bargaining pairs over more than two decades with the view to examining, not the collective bargaining outcomes at a point in time that have been studied so far, but the long run history of the outcomes implied in these bargains. We focus on real wage chronologies that trace out the history of the real wage for each pair in the sample. This is an approach that has not been followed so far and one that, hopefully, casts light on the long run behaviour of this all-important variable.

We generate the average annual growth rate in the real wage for each chronology and study the influence of productivity growth, the speed with which the bargaining pair can reach agreements and the initial wage on this growth rate. We do so controlling for and estimating industry and region effects that are consistent with intensification of the stylized facts on inter-industry and regional wage patterns. We find that productivity growth and the bargaining skills of the pair influence the long-run growth in the real

wage. Convergence in real wages, controlling for the other variables mentioned above, appears to be at work and it is quantitatively strong. An inverse relation between the mean and the variance in the real wage sequence in a chronology is also present and it is quantitatively important.

The results in this paper pertain to the unionised sector, of course. While long run analysis of this kind is only possible because of the nature of the information in this sample, the results obtained may illuminate behaviour in the broader economy. The employees covered by this data represent 11% of the Canadian labour force; to the extent that similar results hold for contracts involving small numbers of employees, our findings would be more broadly applicable. It is worth recalling that, in contrast to the US, union membership in Canada as a proportion of non-agricultural employment is relatively high (32% in 1999). As longer panels on individuals become available, it would be interesting to focus on the long run labour market experience of individuals, appropriately averaged over wide-enough groups to remove idiosyncratic effects. To our knowledge, these individual-based chronologies have not been studied.

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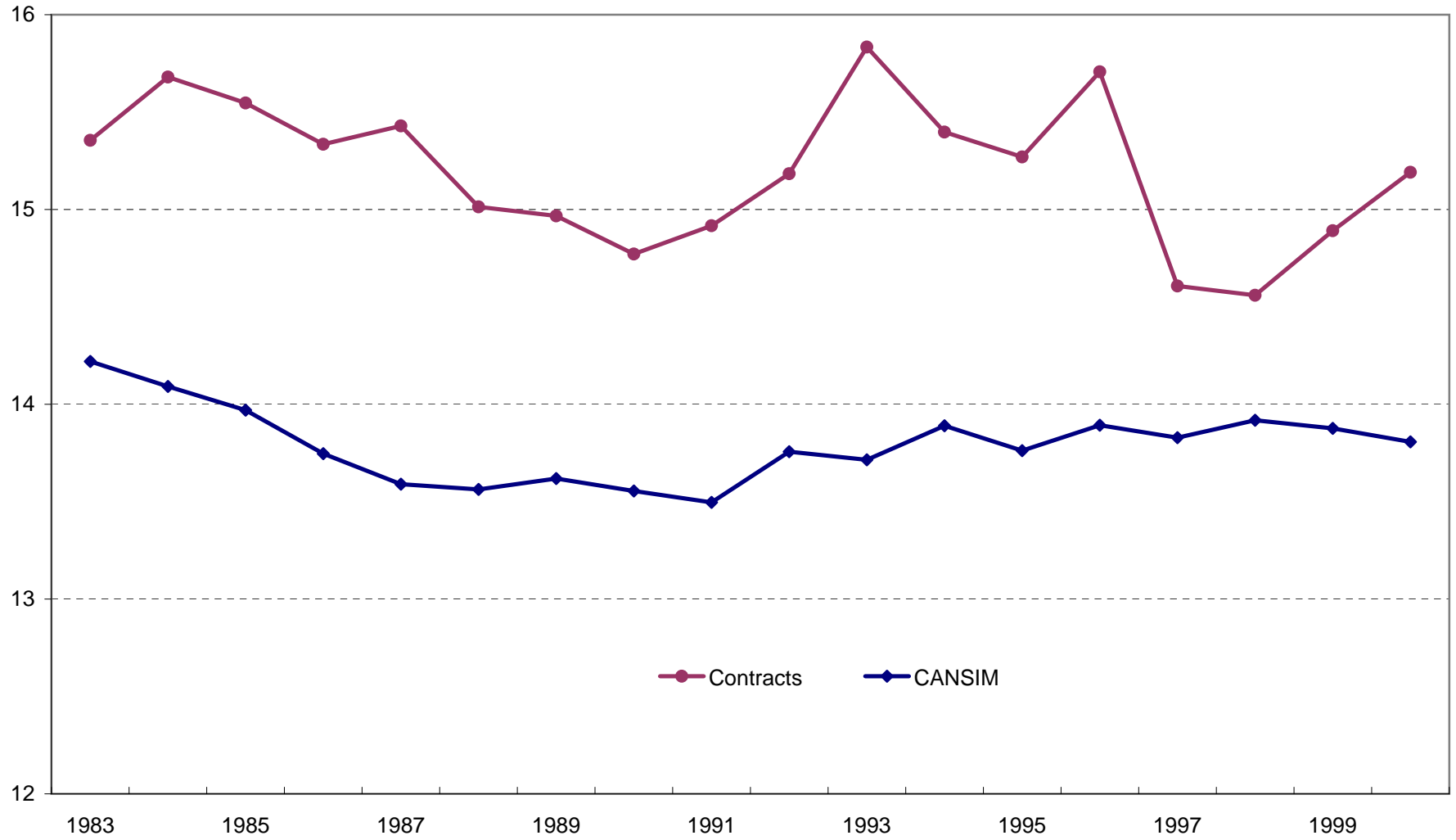


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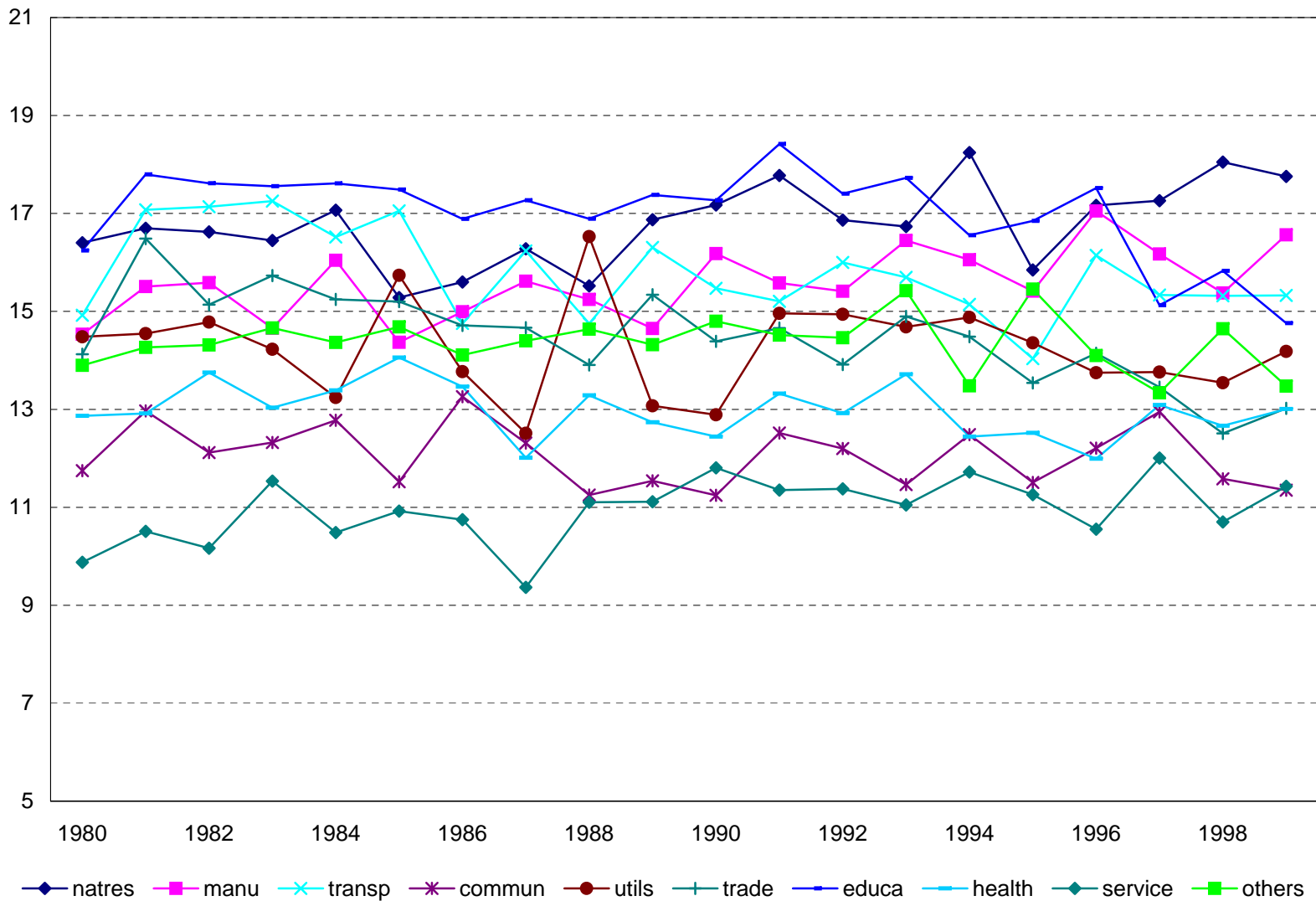
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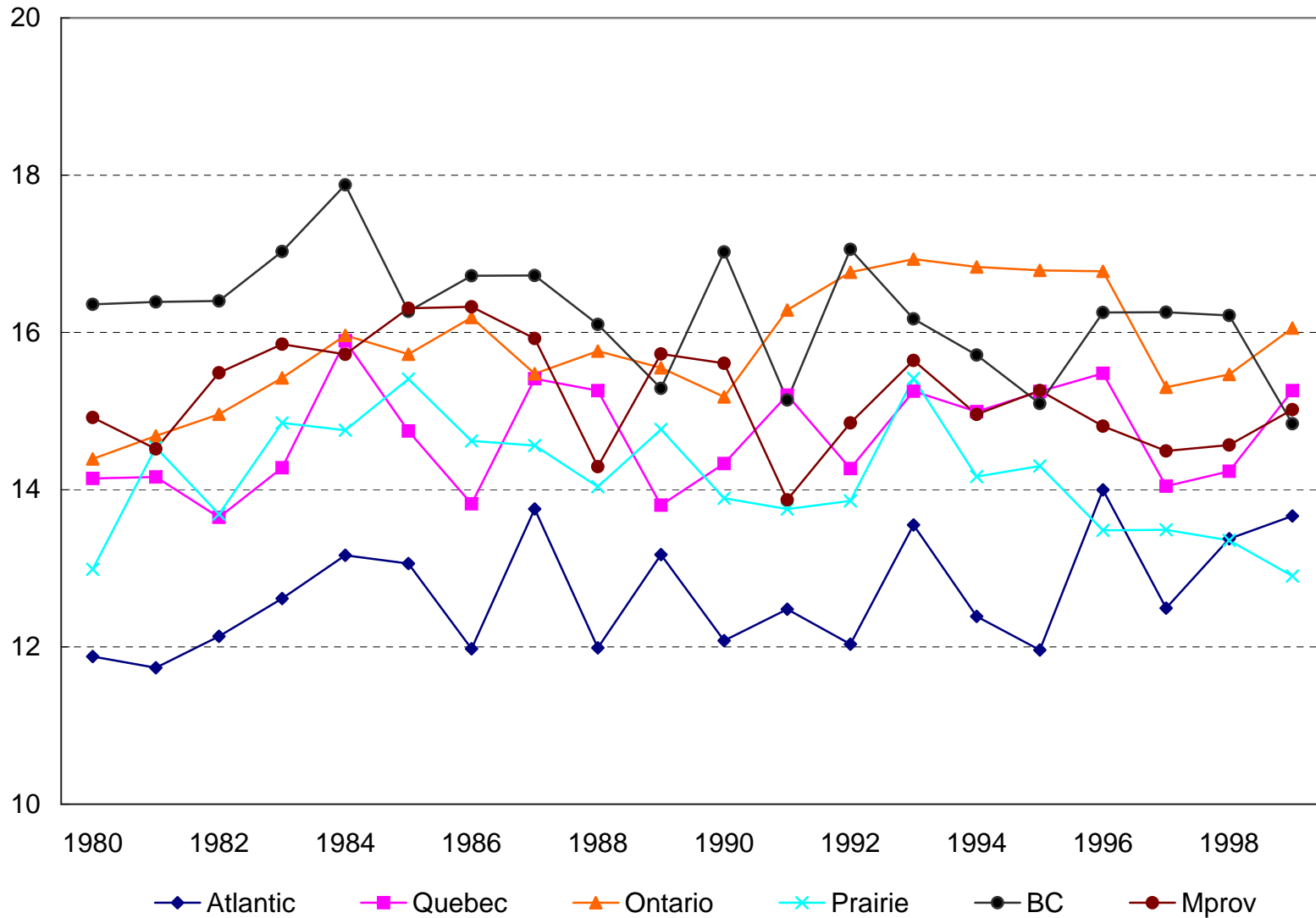
**Figure 1**  
**Hourly Real Wages From Contracts and Earnings From CANSIM**



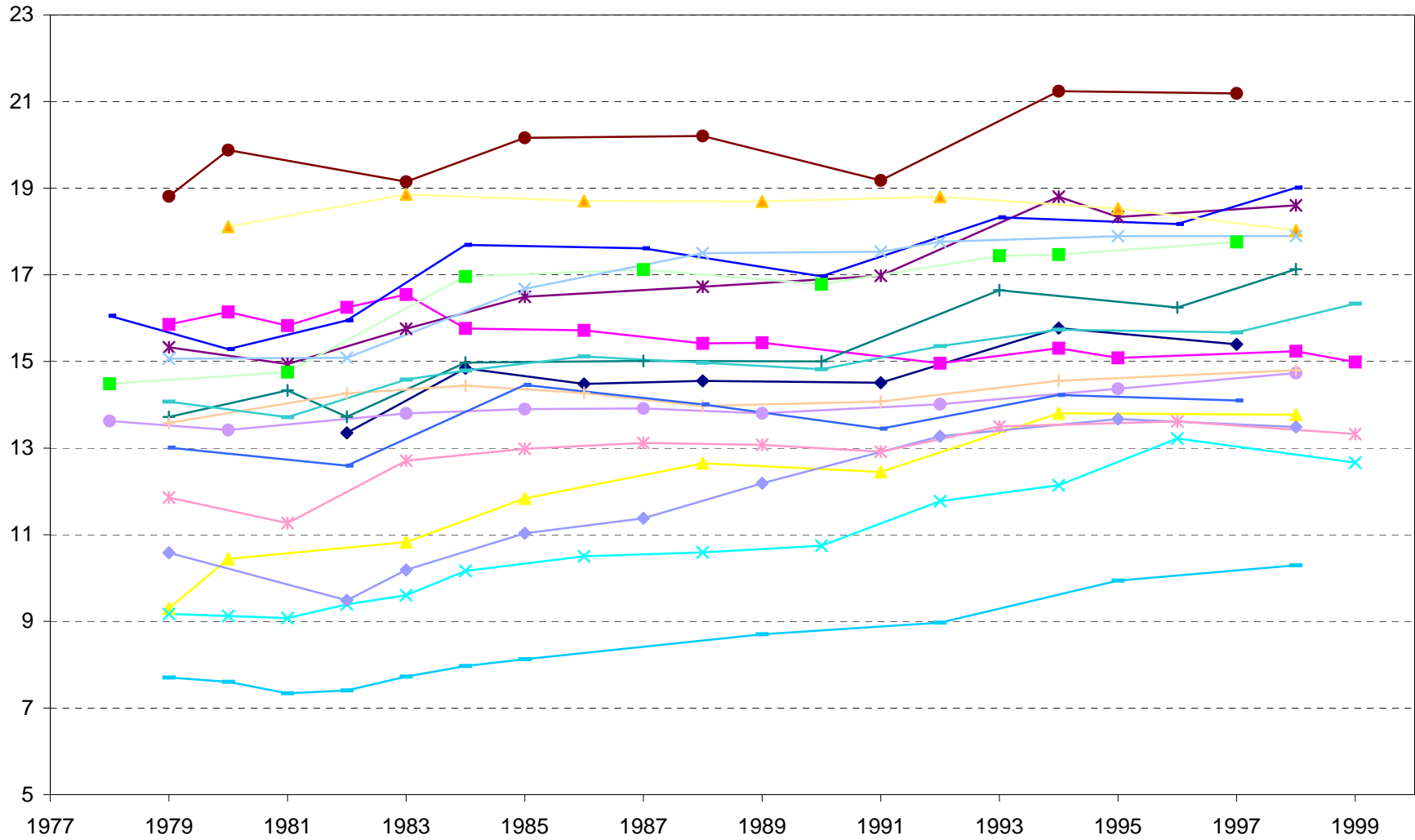
**Figure 2**  
**Annual Average Hourly Real Wage by Industry From Contracts**



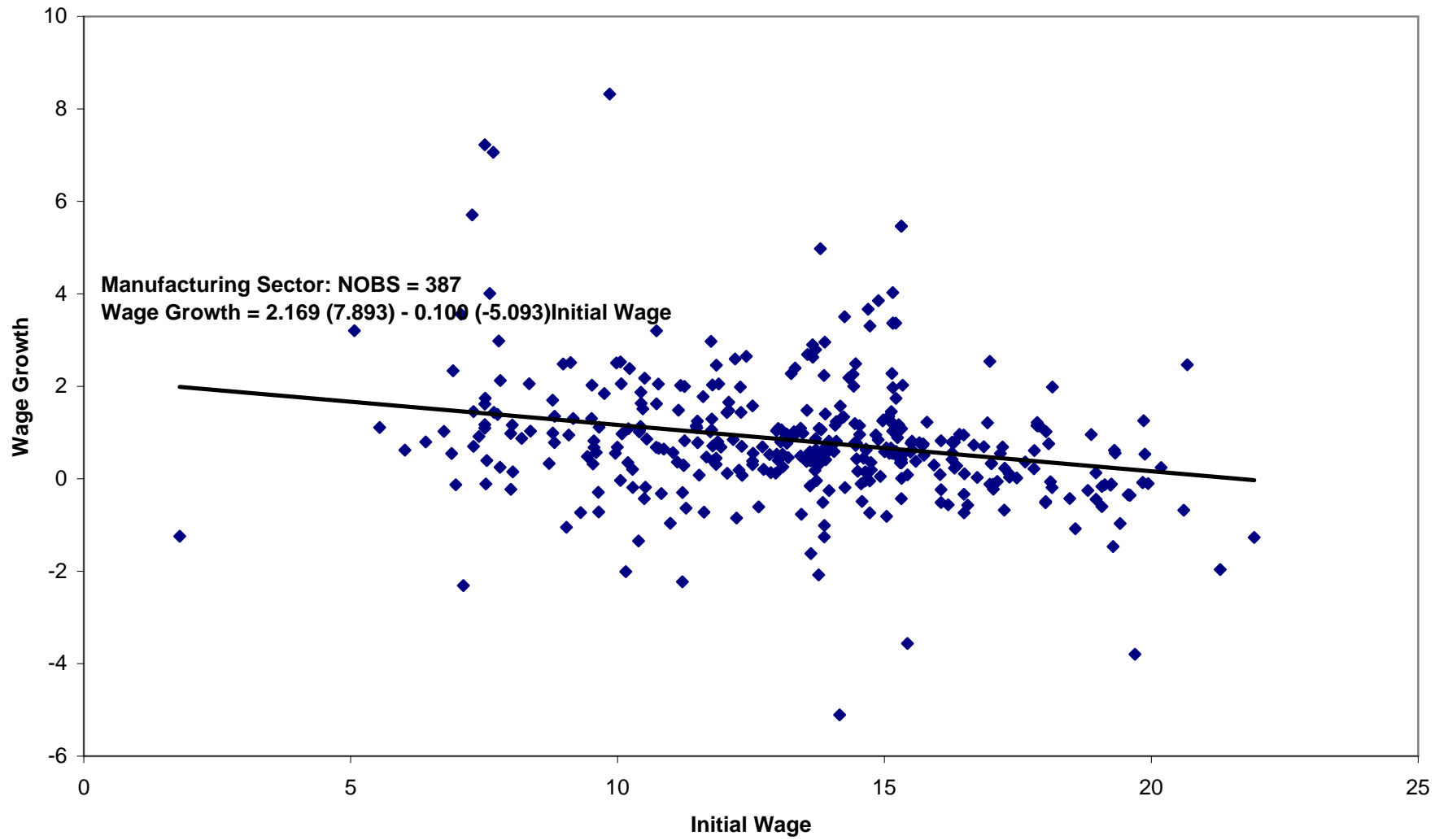
**Figure 3**  
**Annual Average Hourly Real Wage by Region From Contracts**



**Figure 4**  
**The Longest Contract Chronologies in the Manufacturing Sector**



**Figure 5**  
**Scatter Plot of Chronology Wage Growth on Initial Wage (Manufacturing Sector)**





**Table 1**  
**Summary Statistics Based on the Number of Contracts (NOBS 8928)**

<b>Variable</b>	<b>Definition</b>	<b>Mean</b>	<b>St. Dev.</b>
<b>Pexpwage</b>	Nominal Wage at Expiry of Previous Contract	12.66	4.55
<b>Expwage</b>	Nominal Wage at Expiry of Current Contract	13.69	4.57
<b>Rpexpwage</b>	Real Wage at Expiry of Previous Contract	15.13	3.99
<b>Rexpwage</b>	Real Wage at Expiry of Current Contract	15.24	4.00
<b>Duration</b>	Length of the Contract (Months)	25.41	11.62
<b>W dot</b>	Nominal Wage Adjustment (Annual %)	4.85	4.26
<b>Nat. Res.</b>	Natural Resouce Sector	0.03	0.17
<b>Manufact.</b>	Manufacturing Sector	0.20	0.40
<b>Transport</b>	Transportation Sector	0.09	0.28
<b>Commun.</b>	Communication Sector	0.04	0.19
<b>Utilities</b>	Utility Sector	0.03	0.17
<b>Trade</b>	Trade Sector	0.04	0.21
<b>Education</b>	Education Sector	0.27	0.44
<b>Health</b>	Health Sector	0.09	0.29
<b>Service</b>	Service Sector	0.03	0.18
<b>Others</b>	Other Sectors	0.18	0.38
<b>Atlantic</b>	Atlantic Region	0.07	0.25
<b>Quebec</b>	Quebec	0.16	0.36
<b>Ontario</b>	Ontario	0.35	0.48
<b>Prairies</b>	Prairie Region	0.17	0.38
<b>BC</b>	British Columbia	0.12	0.32
<b>Territories</b>	Territories	0.00	0.07
<b>Multi Prov.</b>	Muti-province Contract	0.13	0.34

**Table 2**  
**Summary Statistics Based on Real Wage Chronologies (NOBS 1574)**

<b>Variable</b>	<b>Definition</b>	<b>Mean</b>	<b>St. Dev.</b>
<b>Grate</b>	Real Wage Growth Rate (Annual, Fraction)	0.0032	0.0136
<b>W<sub>0</sub></b>	Real Wage at the Start of Chronologies	14.43	3.94
<b>W<sub>0</sub> - Projected</b>	Real Wage Projected to 1980	14.62	4.70
<b>W<sub>0</sub> - Instrument</b>	Real Wage Projected to 1980 - instrument	14.62	3.29
<b>Length</b>	Length of Chronology (Years)	12.01	7.20
<b>Count</b>	Number of Contract Renewals	5.67	3.93
<b>Durneg</b>	Duration of Negotiations	8.18	4.37
<b>Pdurneg</b>	Duration of Negotiations of Previous Contract	7.74	4.05
<b>Nat. Res.</b>	Natural Resouce Sector	0.04	0.19
<b>Manufact.</b>	Manufacturing Sector	0.25	0.43
<b>Transport</b>	Transportation Sector	0.11	0.31
<b>Commun.</b>	Communication Sector	0.04	0.20
<b>Utilities</b>	Utility Sector	0.02	0.16
<b>Trade</b>	Trade Sector	0.06	0.24
<b>Education</b>	Education Sector	0.19	0.39
<b>Health</b>	Health Sector	0.10	0.31
<b>Service</b>	Service Sector	0.04	0.21
<b>Others</b>	Other Sectors	0.14	0.34
<b>Atlantic</b>	Atlantic Region	0.06	0.24
<b>Quebec</b>	Quebec	0.19	0.39
<b>Ontario</b>	Ontario	0.33	0.47
<b>Prairies</b>	Prairie Region	0.14	0.35
<b>BC</b>	British Columbia	0.12	0.32
<b>Territories</b>	Territories	0.00	0.07
<b>Multi Prov.</b>	Muti-province Contract	0.15	0.35
<b>Prod</b>	Labour Productivity Growth	0.0171	0.0183

**Table 3**  
**Weighted Regression of Long Run Chronology Real Wage Growth**

<b>Result</b>	<b>I</b>		<b>II</b>		<b>III</b>		<b>IV</b>		<b>V</b>	
<b>Variable</b>	<b>coeff</b>	<b>t stat</b>	<b>coeff</b>	<b>t stat</b>	<b>coeff</b>	<b>t stat</b>	<b>coeff</b>	<b>t stat</b>	<b>coeff</b>	<b>t stat</b>
<b>Intercept</b>	0.0037	5.64	0.0492	24.11	0.0624	26.00	0.0442	11.4	0.0544	8.62
<b>Prod</b>	0.0626	3.53	0.0867	5.65	0.0530	3.21	0.0840	5.43	0.0506	3.04
<b>Durneg</b>	-0.0004	-8.06	-0.0003	-5.97	-0.0002	-3.74	-0.0003	-6.15	-0.0002	-3.97
<b>Ln W<sub>0</sub></b>			-0.0178	-23.21	-0.0212	-25.23	-0.0158	-10.56	-0.0182	-7.62
<b>Nat. Res.</b>					0.0036	2.08			0.0033	1.87
<b>Transport.</b>					-0.0012	-1.13			-0.0013	-1.17
<b>Commun.</b>					-0.0057	-4.91			-0.0055	-4.74
<b>Utilities</b>					-0.0037	-2.33			-0.0038	-2.41
<b>Trade</b>					-0.0052	-4.78			-0.0053	-4.82
<b>Education</b>					-0.0034	-3.86			-0.0042	-3.93
<b>Health</b>					-0.0045	-5.26			-0.0045	-5.26
<b>Services</b>					-0.0076	-4.81			-0.0063	-3.44
<b>Others</b>					-0.0083	-9.82			-0.0079	-8.86
<b>Atlantic</b>					-0.0031	-2.50			-0.0023	-1.70
<b>Quebec</b>					-0.0019	-2.37			-0.0016	-1.83
<b>Ontario</b>					0.0033	4.13			0.0034	4.20
<b>Prairies</b>					-0.0020	-2.29			-0.0016	-1.61
<b>BC</b>					0.0005	0.54			0.0000	0.04
<b>Territories</b>					0.0091	1.99			0.0093	2.03
<b>Adj. R Sq.</b>	0.0503		0.2924		0.3926		0.1239		0.2166	

**Table A1**  
**Weighted Regression of Long Run Chronology Real Wage Growth (Endogenous Durneg)**

Result	Pdurneg and Instrumented Wage						Instrumented Durneg and Wage					
	coeff	t stat	coeff	t stat	coeff	t stat	coeff	t stat	coeff	t stat	coeff	t stat
<b>Intercept</b>	0.0025	3.98	0.0442	10.73	0.0473	8.77	0.0052	5.23	0.0447	11.48	0.0471	9.21
<b>Prod</b>	0.0809	4.55	0.0748	4.84	0.0347	2.02	0.0565	3.13	0.0748	4.90	0.0347	2.03
<b>Durneg</b>	-0.0004	-6.17	-0.0004	-7.04	-0.0003	-5.01	-0.0006	-6.20	-0.0003	-3.77	-0.0002	-1.97
<b>Ln W<sub>0</sub></b>			-0.0157	-10.21	-0.0149	-7.65			-0.0159	-10.55	-0.0150	-7.81
<b>Nat. Res.</b>					0.0030	1.61					0.0030	1.62
<b>Transport.</b>					-0.0014	-1.25					-0.0014	-1.26
<b>Commun.</b>					-0.0058	-4.70					-0.0058	-4.73
<b>Utilities</b>					-0.0033	-1.96					-0.0033	-1.97
<b>Trade</b>					-0.0059	-5.20					-0.0059	-5.24
<b>Education</b>					-0.0070	-7.49					-0.0070	-7.54
<b>Health</b>					-0.0056	-6.68					-0.0056	-6.72
<b>Services</b>					-0.0035	-2.06					-0.0035	-2.07
<b>Others</b>					-0.0058	-6.71					-0.0058	-6.75
<b>Atlantic</b>					-0.0021	-1.51					-0.0021	-1.52
<b>Quebec</b>					-0.0024	-2.73					-0.0024	-2.74
<b>Ontario</b>					0.0019	2.21					0.0019	2.23
<b>Prairies</b>					-0.0016	-1.62					-0.0016	-1.63
<b>BC</b>					-0.0030	-3.43					-0.0030	-3.45
<b>Territories</b>					0.0075	1.58					0.0075	1.59
<b>Adj. R Sq.</b>	0.03431		0.10171		0.1962		0.0347		0.0104		0.1981	