

Late height growth from historical individual-level panel data*

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Abstract

This article shows that one can combine height information in two sources from the French conscription to build an individual-level panel of men. The *tableau de recrutement cantonal* gives height of Frenchmen during their twenty-first year when they are to be selected for military service. The *fiches matricules* pertain to selected men from 6 to 22 months later. An illustration on the 2,923 men born in 1887 in the department of Corrèze yields a 0.34cm yearly growth from 1908. Growth concerns the shortest men; the tallest already reached adult maturity.

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1 Introduction

In the absence of reliable data on income or wealth, anthropometric variables, in particular the height of the man, are common proxies for well-being and economic development. Indeed height, as a key criterion of military aptitude, is often easily available from the archives of the military administration. Louis-René Villermé [48] was probably the first scholar to highlight from such a source a correlation between the height of French conscripts at the beginning of the nineteenth century and the ‘degree of ease or misery’ of the region where they live. This correlation has been largely confirmed by subsequent studies¹ and now there exists a vast literature relying on the average height of cohorts of different individuals to assess local economic development over the last centuries.²

However we still know very little about individual height growth for periods preceding World War II. This is mostly due to data limitations, as large individual-level panel data sets were only developed after 1945 to provide child growth national standards to paediatricians (see Sempé and al. [44] for France).³ So far human auxology has therefore mostly relied on cross-sectional cohort analysis, rather than longitudinal individual-level panel data, to recover historical height-for-age growth chart by computing for each age the average height of different individuals.⁴ The averaging procedure made in cross-sectional cohort analysis may prevent us to observe individual growth patterns (Tanner [45]), and yield biased estimates as soon as there is some differential selection of individuals into the sample (Schneider [43]). The in-

¹See Fogel et al. [21], Robert Fogel [20], John Komlos [29], Roderick Floud and Richard Steckel [18] for classical synthesis of this literature. Recent evidence from event studies can be found in Abhijit Banerjee et al. [4] and Cogneau and Kesztenbaum [11].

²See, *e.g.*, Weir [49] or Floud et al. [19]. Seminal studies on France are Chamla [10] and Aron et al. [2]. Heyberger [25] uses a large height sample from conscription data in Limousin, a region of France which includes the department of Corrèze. For a focus on children, see Flood et al. [17] or Komlos [30].

³See Case and Paxson [9] for a panel study on British children born in 1958. Longitudinal data on healthy United States children are available from the Brush Foundation Study of Child Growth and Development starting in 1931, and on children born in Berkeley in 1928-29 from the Berkeley Guidance Studies of the Institute of Human Development. Both are used in, *e.g.*, Sanders et al. [42].

⁴See Cameron [8], Rosenbaum [41], Nicholas and Steckel [34], Harris [24], Cole [12] or A’Hearn et al. [1]. Houdaille [26] uses cross-sectional strategy to study growth of adolescents from 15 to 19 in the early nineteenth century in France.

novation of this article is to show that one can combine two military data sources from France to build a quasi-exhaustive longitudinal individual-level panel of young men measured twice when they are about 20. For illustrative purpose the panel is used to measure individual height growth of the men born in 1887 in the department of Corrèze, an economically backward rural area of France.

There exist two main sources on height for the nineteenth century in France. The first source is the recruitment table (*tableau de recrutement cantonal*) that reports the height at the moment where young men are examined by the review board (*conseil de révision*), a committee set up under an imperial decree of 1804 to select draftees. The second source comes from individual soldiers' registration forms (*fiches matricule*), which are considered as an avatar of vetting of troops records becoming more generally used from 1716 to avoid multiple enlistments and keep track of deserters; see André Corvisier [15] for a history of these forms.

These two sources have already been widely used and they are often thought as providing about similar information on height. It is known that they display slight differences in their scopes. The recruitment table does not include information on men who do not appear before the review board, and there is no registration form created for the men deemed unfit by the review board. These possibly negligible differences should however draw our attention to a crucial point: the two sources pertain to two different points in time. The recruitment table reports the height of young men before enlistment, when they are to be selected by the review board. Instead the registration forms are used as internal soldiers' ID documents by the military administration and so refer to some post-enlistment period.

So far this observation has not been exploited. Indeed there exists no systematic individual-by-individual comparison of the height information contained in these two sources. This article shows that the information differs. It makes use of the body of the legal military texts to reconstitute the main steps of the enlistment process and identify the (approximate) moment at which the height in the registration form was recorded. It appears that the time spent between the height measurements available in the two sources in general is either between 6 and 10 months or between 18 and 22 months.

Combining the recruitment table and the registration forms yields a longitudinal individual-level panel on young men after having reached age 20. In

principle the resulting panel can be used to assess individual height growth of men when they are about 20 over the whole nineteenth century in every region of France. The panel is quasi-exhaustive for cohorts born in the late nineteenth century as most men from these cohorts were exceptionally reexamined in the course of military recall procedures implemented during World War I. The French Army then being much less attentive to previously demanding military aptitude criteria, many men exempted from military service before the war were eventually sent to the front lines, and so subject to a late registration form. One cannot achieve a fully exhaustive sample since the height of the (small number of) men absent from the review board is definitively lost.

Given the system of compulsory universal conscription in use in France, one may argue that the panel is about immune to sample selection issues for cohorts of 20-year-old males subject to military recall. However the measurement of height growth is not immune to endogeneity issues. Indeed the time elapsed between the two height measurements on the same man depends on the evaluation made by the review board about his individual aptitude. The legal recommendation was to postpone the decision on every poor health man to the next meeting of the review board in the following year. This is why we observe in the data a concentration on 6 to 10 and 18 to 22 months for the time between the height measurements. The health status and height growth potential are very likely correlated: the data suggest that those with the weakest growth potentials end up measured over a longer period of time.

One can deal with endogeneity issues by appealing to an instrumental variables approach in the case of the specific cohort of men born in 1887 in Corrèze, a rural area of France. When all these men were subject to an examination by the review board in 1908, the chairman was the Prefect Georges Calmès, a short man previously exempted from military service. If temporarily absent from some session of the review board, the Prefect was replaced by the Secretary (*secrétaire général*) of the Prefecture Charles Filhoulaud. It appears that Calmès was much more willing to postpone decisions than Filhoulaud.

Using the actual head of the review board as an instrument, I first find that the men born in 1887 in Corrèze are still growing-up after 20. The average height gain is between 0.29 and 0.39cm over one year. Late growth was commonplace at the turn of the nineteenth century: some have even proposed

a delayed enlistment to reduce the volume of exemptions (the difficulties encountered by short men to handle long rifles then justified exemption) arguing that many men did not reach adult maturity at 20-year-old (Rampal [38]).

A second result from this illustration is that growth mostly concerns the shortest men: those men with a height above the average height of the cohort when examined by the review board in 1908 have already reached adult maturity. It is the more physically and possibly economically disadvantaged who still grow at 20 and so catch up slightly to their more well off peers.

The scarcity of individual-level panel data before World War II makes very narrow the literature that characterizes historical height growth of the man.⁵ A classic reference is the work of Adolphe Quételet [36] building as early as 1835 a growth chart giving height for most ages until adult maturity from a small sample of children selected in schools, boarding schools and orphanages in Brussels. In his 1870 revised chart, he reports a total growth of 1.3cm from 20 to 25-year-old. The first modern insights on historical height growth have been recently obtained by Gao and Schneider [23] using longitudinal individual-level panel data on repeated samples of selected destitute boys assigned to the training ship *Indefatigable* over a long period from the 1860s to the 1990s. The boys were between 10 and 18-year-old, thus encompassing the period of adolescence, but stopping two years before men were concerned by conscription in France. There are two studies on men in their late growth stage. Beekink and Kok [5] and Thompson, Quanjer and Murkens [47] exploit subsamples of self-selected Dutch conscripts measured twice, first at 19 and then at 25 when they decide to apply to the civil guard of Woerden and Maastricht, respectively. Both find evidence of late growth and catch-up.

The article is organized as follows. I first provide in Sections 2 to 4 evidence that one indeed faces two different height measurements in the data. Section 2 describes the two data sources that I combine, the recruitment table and the registration forms. Section 3 shows that height information contained in these two sources differ and discusses legal evidence on the time at which the height recorded in the registration forms was taken. Section 4 finally sets the taxonomy used in the article for classifying the time elapsed

⁵A recent important research effort is devoted to building historical panel data. For instance Bailey, Hatton and Inwood [3] and Gregori Galofré-Vilà [22] combine military data with census records to analyze how soldiers' height relates to childhood circumstances. The census does not contain height information which prevents to reconstitute some height growth episode. See Beekink and Kok [5] for other references.

between the two height measurements. The reader willing to accept that the difference in the height reported in the two sources reflects growth of the man can pass directly on to Section 5 for descriptive statistics on height level and height growth of the 2,923 men born in Corrèze in 1887. Section 6 gives OLS and IV height growth estimates from various fixed effects models. Section 7 concludes.

2 Two different data sources

2.1 Military draft under the 1905 Berteaux Law

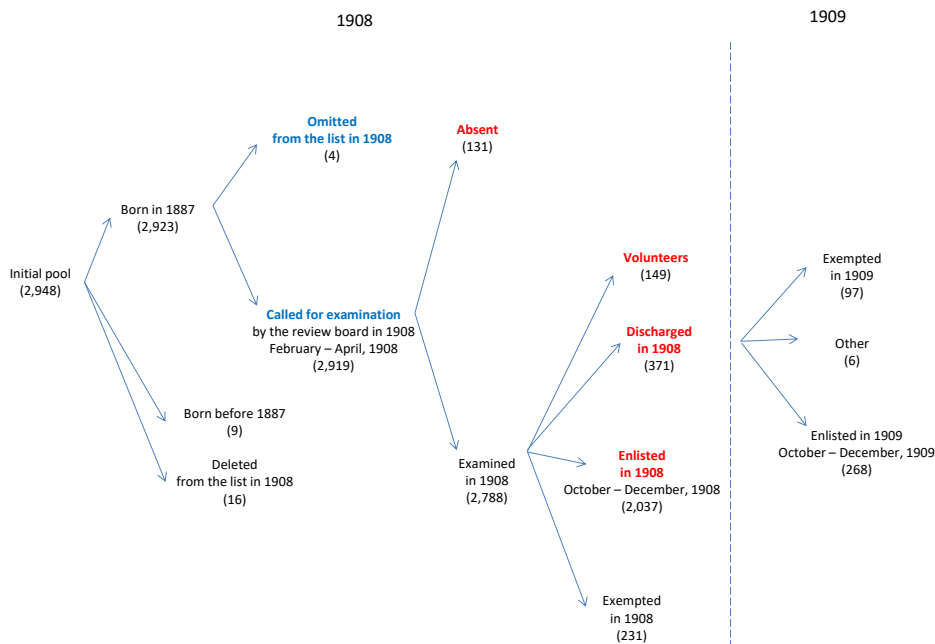
Following the Maurice Berteaux Law [33] of 21 March 1905, a comprehensive census of all French men born in $t-20$ must be conducted in each municipality at the end of every year t . The men from the municipalities of the same county are called to be examined within the same session by the review board (*conseil de révision*) early in year $t+1$, usually between February and April. The purpose of this examination is to select men fitting for military service. Men can be allowed for an examination by the review board operating where they live, but the final enlistment decision always remains with the review board operating in their county of birth. The review board thus rules on every man still living at 20 and born in the county, irrespective of his actual place of residence.

Men deemed fit for service by the review board are enlisted (*incorporés*) during the fall of $t+1$, usually between October and December, so about 2 quarters after the examination by the review board.

The others are either exempted (*exemptés*) from service or discharged (*ajournés*). In principle exemption implies that the man will never enter the Army; however men exempted before the Great War were reexamined in the course of several waves of exceptional military recall procedures throughout the hostilities, and many were eventually enlisted during the war.

In the case of discharge the review board merely postpones its decision to year $t+2$, when the men born in $t-19$ in the county will in their turn be subject to examination. If the man discharged in $t+1$ is deemed fit by the review board in $t+2$, then he is enlisted during the fall $t+2$, about 6 quarters after the examination by the review board in year $t+1$. Otherwise the law states that he must be definitively granted for exemption, but this is once again subject to the same caveat involving exceptional military recall

procedures. The whole sequence of events is summarized in Figure 1.



The men measured during the examination by the review board (with a height reported in the recruitment table) appear in bold blue. Those who should theoretically be subject to a registration form appear in bold red. The number of men concerned by conscription in Corrèze in 1908 are into brackets. For instance there were 2,919 men born in Corrèze in 1887 called for an examination by the review board in 1908. They all appear in the recruitment table, including 131 men who did not respond to the summons. In principle, a registration form exists for each of these men, except 231 men exempted from military service in 1908. In fact, the data contains registration forms for some exemptees (see Table 1).

Figure 1: ENLISTMENT TIMELINE

2.2 Recruitment table and registration forms

There exist two main individual-level data sources on the same men. Both are well known from scholars and have been widely used separately. The first source comes from the height recorded during the examination by the review board. It is reported in the recruitment table (*Tableau de recrutement*

cantonal), a report which completes the initial censuses made by the municipalities of the county with the information collected during the examination.⁶ The date on which the review board is held was publicly widely advertised. Today it can be found at the front of the recruitment table, in local newspapers, or in the *Bulletin des Actes Administratifs* official publication.

The second source originates from individual registration forms (*fiches matricule*). They were created for every man enlisted or discharged by the review board. They were used by the military administration to keep track of the military cursus of the man over the whole 25 year period of military service (with only the first two years of active duty).

Both sources contain basic civil status information, an occupation and some literacy indicator. They also give an anthropometric description indicating the color of hair, eyebrows and eyes; the shape of forehead, nose, mouth and chin, followed by a general statement about the shape of the whole face of the man. The recruitment table reports the height of every man and sometimes his weight. The registration form has two items for the height and a corrected height (*taille rectifiée*).

While nowadays the recruitment table can only be found in the archives, access is very easy to the registration forms. Indeed a scanned sample of all forms was prepared as part of the *Mémoire des Hommes* national project to celebrate the hundredth anniversary of World War I. It is freely available for each department of France from the *Archives départementales* websites.⁷ The project also includes digitized individual registration form information about civil status, occupation and literacy. The *Archives départementales de la Corrèze* provided me with the digitized file of all men born in Corrèze between 1863 and 1901. I completed this file with information from the recruitment table on men born in Corrèze in 1887 and exempted by the review board in 1908. For every observation in the resulting exhaustive sample of all the men born in Corrèze in 1887 and reaching 20-year-old in 1907, I entered additional (handwritten) information from the recruitment table: the height, the review board that actually examined the man, and the exemption/discharge/enlistment decisions made by the review board in 1908 and 1909. In addition, for every man with a registration form, I entered

⁶Other designations of the same data source include *liste du contingent départemental*, *liste générale de recrutement*, and more often *liste du tirage au sort*.

⁷Access for Corrèze follows the link <http://www.archinoe.fr/cg19/recrutement.php>.

his (handwritten) enlistment date, his height and, if available, his corrected height (*taille rectifiée*).

2.3 Height completion in the two data sources

Figure 1 reports in brackets the numbers of men born in Corrèze in 1887 involved in the various steps of the enlistment process in 1908 and 1909. The initial 2,948 sample includes a few men born before 1887 but omitted from the census in the previous years, as well as some men who do not fall within the competence of the review board of Corrèze. Hereafter the analysis starts with the 2,923 men born in 1887 and falling within the competence of the review board of Corrèze. Most of them were examined in 1908 (only 4 were omitted in 1908 and examined later). They all appear in the recruitment table. The blue bold writing in Figure 1 delineates the scope of men concerned by the 1908 review board.

In principle an individual registration form is created for all the 2,919 men called for an examination by the review board in 1908, except 231 men who are exempted from military service in 1908. The theoretical scope of the registration forms is marked in bold red in Figure 1. It applies to the regular case of men enlisted in the fall of 1908, and to those discharged in 1908, whatever the outcome of the examination by the review board in 1909 is. It also covers 149 volunteers, who decided to enlist before being called, and 131 men absent from the review board of 1908 (absentees are considered suitable to serve). Again this theoretical scope is subject to the proviso that many men exempted in 1908 were actually reexamined throughout the war: men from Corrèze were involved in three consecutive waves of recall occurring in 1914, 1915 and 1917. Thus some men exempted in 1908 eventually entered the army, and in this way they were subject to a late registration form.

Table 1 adds to the timeline of Figure 1 some information about the number of completed/missing individual height in the recruitment table and the registration forms. Height may be missing either because the man does not appear in the source or because his height is left blank. Table 1 shows that there are two cases where height information is more likely to be missing. First height is obviously missing in the recruitment table for men who did not obey the review board summons. Second men exempted in 1908 and never recalled during the Great War do not appear in the registration forms and so their height remains unknown in this source. Table 1 highlights the

Table 1: HEIGHT COMPLETION

	Number of men	Number of men with a missing height in the		Number of men with a filled height in both sources
		recruitment table	registration form	
Initial sample	2,948	141	238	2,623
Men removed from the list	16	14	15	1
Men born before 1887	9	1	3	6
Men born in 1887	2,923	126	220	2,616
Men omitted from the list in 1908	4	0	0	4
Men called in 1908	2,919	126	220	2,612
Absentees in 1908	131	124	42	3
Examined by the review board in 1908	2,788	2	178	2,609
Volunteers	149	0	2	147
Enlisted in 1908	2,037	0	12	2,025
Exempted in 1908	231	1	142	89
Discharged in 1908	371	1	22	348
Enlisted in 1909	268	1	9	258
Exempted in 1909	97	0	13	84
Other	6	0	0	6

Reading: There are 2,025 out of 2,037 men enlisted in 1908 with a height completed in both the recruitment table and the registration form. The height of each of the 2,037 men is always completed in the recruitment table (filled during the review board). It is missing for 12 men in the registration forms.

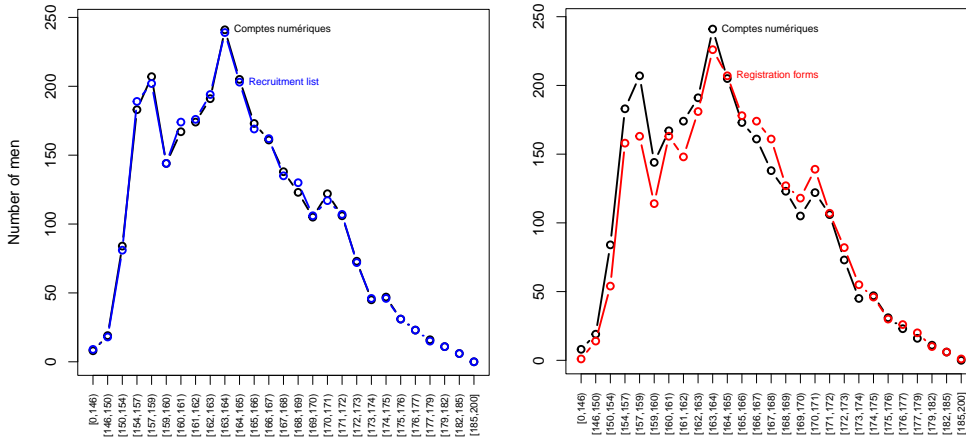
impact of the recall procedures, as height is known in $231 - 142 = 89$ men exempted in 1908 (height is also available in the recruitment table for each of them).

3 Assessing the height growth hypothesis

3.1 Evidence from height distributions

Figure 2 refers to the height distribution in the summary statistics published every year for each department of France since the beginning of the nineteenth century in the *Comptes Numériques et Sommaires du Recrutement de l'Armée*. It plots the number of men (in the vertical axis) in every height class considered in the *Comptes Numériques* [14] for men born in Corrèze in 1887. The large 4cm intervals used at the bottom of the distribution in the *Comptes Numériques* yield excess masses of short men that are soften when considering the exact height available in the data. It is clear that the distribution in the *Comptes Numériques* (in black) originates in the height information from the review board recorded in the recruitment table (in blue). Instead the right panel shows a significant discrepancy between the height distribution in the *Comptes Numériques* and the distribution coming from

registration forms (in red). There is a huge deficit of short men in the registration forms for every height below the peak at 163cm. This goes with an excess number of men taller than 163cm in the registration forms.

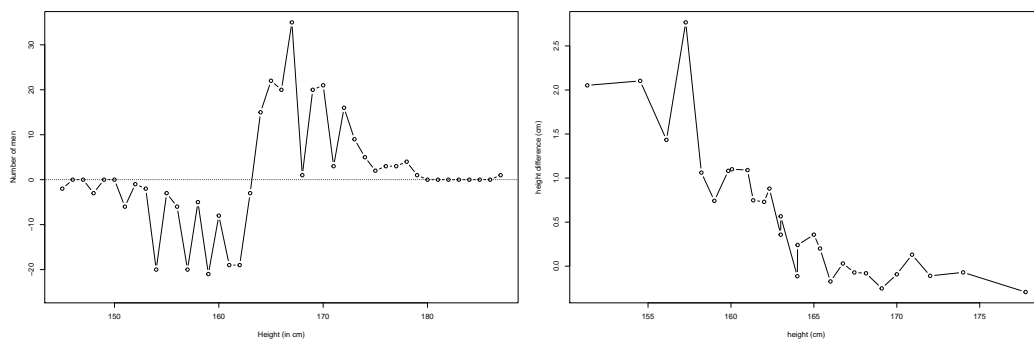


The Figure considers three height distributions giving the number of men born in Corrèze in 1887 per height class. The black distribution, which corresponds to the summary statistics publicly released in the *Comptes numériques*, is used as a reference in the two panels. The blue distribution in the right panel (resp., red in the left panel) counts the number of men (in the vertical axis) in each height class (in the horizontal axis) in the recruitment table (resp., the registration forms). There are 144 men whose height is between 159 (excluded) and 160cm in both the *Comptes numériques* (black) and the recruitment table (blue); in the registration forms (red) there are only 114 men with a height in this same class (159, 160). Note the larger height intervals used in the *Comptes numériques* yielding anomalous masses of men at the bottom of the height distributions.

Figure 2: Comparing height distributions

The left panel of Figure 3 zooms on the spread between the number of men in the registration forms and the recruitment table. The vertical axis now refers to the exact height available in the original data, not the height classes considered in the *Comptes numériques*. The deficit of short men in the registration forms is widening as one approaches the peak of 163cm in Figure 2. Instead the excess of tall men in the registration forms dampens as one moves away from the peak.⁸

⁸The saw-tooth patterns may result from some height rounding during the examination by the review board. Also the existence of height thresholds to enter specific military



Excess number of men

Average height difference

One-centimeter height intervals are used in the horizontal axis of both panels. The left panel reports for each height the difference between the number of men in the registration forms and the recruitment table. There are 21 men measuring 160cm (with height in the $(159, 160]$ interval) less in the registration forms than in the recruitment table; there are 35 men measuring 168cm more in the registration forms than in the recruitment table.

In the right panel men are first ranked in the order of increasing height in the recruitment table. For every 100 men, I compute the average height in the recruitment table (it is reported in the horizontal axis) and the average difference between the height in the registration forms and the height in the recruitment table. The average height of 100 shortest men in the recruitment table is 151.34cm and the average height difference for these men is 2.05cm. The point corresponding to the next 100 shortest men has 154.52cm in the horizontal axis and a 2.10cm height difference in the vertical axis.

Figure 3: Men and height spreads

Of course some discrepancy is to be expected as the scopes of the recruitment table and the registration forms differ. Short men exempted from military service together with tall absentees before the review board contribute to the observed shape of the spread between the two distributions. But this is not enough to account for the whole discrepancies. The total deficit in the registration forms amounts to 138 observations, while there are 181 observations in excess in the recruitment table. Instead, Table 1 shows that there are $230 - 142 = 88$ heights of exemptees (to be compared to 138) that appear in the registration forms but not in the recruitment table. Furthermore there are $131 - 42 = 89$ absentees with a height filled in the registration forms, and the height of only 3 among them is completed in the recruitment table, so that there is actually a net deficit of $89 - 3 = 86$ absentees in the recruitment table (to be compared to 181).

The explanation for the discrepancies between the two distributions that I will put forward is that short men during the examination by the review board (their height at this moment appears in the recruitment table) still grow-up after the examination. The height recorded in their registration form in fact is a height they reach after this first examination. As they reach or possibly exceed the peak of 163cm, there is a deficit of short men in the registration forms. They now fall in a class of taller men, which translates into an excess of tall men in the registration forms. The right panel of Figure 2 suggests that the height of tall men when examined by the review board does not significantly change after this examination. This panel reflects a smooth late catching-up, where the difference between the height in the registration form and the height in the recruitment table (in the vertical axis) is shown to be decreasing with the height recorded in the recruitment table (in the horizontal axis), reaching 0 for the tallest men at the review board.

3.2 Procedural evidence: departure and enlistment examinations

The timeline in Figure 1 shows that the registration forms concern men at a stage (in bold red) of the enlistment process coming after the review board

units may yield slight bunching in the registration forms: the law of 2 April 1901 [32] abolished selection to enter the Army based on some minimum height requirement, which was previously set at 154cm, but height was still used as a selection criterion within the Army (see, *e.g.*, Appendix 1 of the military Instruction [28] of April 16, 1910). For instance, minimal height thresholds of 159cm and 170cm were relevant to enter cavalry.

(in bold blue), which suggests that the height recorded in the registration forms indeed can be retaken after the review board. This Section comes to procedural evidence that the height discrepancies between the two data sources can reflect a height growth process, *i.e.*, the fact that short men still grow after the review board while tall men have already achieved adult maturity at this time.

Preliminary insights on a second height measurement come from the particular case of absentees in Table 1. Their height is missing in the recruitment table but it is often available in the registration forms, so that it must be that the Army sometimes completes height in the registration forms after the review board.⁹

The body of military laws enables us to identify the moment at which the second height measurement, recorded in the registration forms, was taken. The military *Instruction* legal text published at the head of the register compiling the registration forms specifies that the ‘register (...) is (...) held by the commander of the recruiting office’. However, unlike the recruitment table completed by the review board, neither this *Instruction* nor, to the best of my knowledge, any other reference statutory text gives the exact moment when the registration form is created. The *Instruction* only states that the ‘recruiting office commanders must start the register as soon as possible’ after the selection of draftees by the review board.

Anecdotal evidence suggests that the Army had reservations against the decisions regarding aptitude made by the review board, which also includes civilian authorities represented by the *Préfecture* of the department and the mayors of the municipalities of the county. The military administration was actually allowed to reconsider the pool of men selected by the review board.

Following the review board, the enlistment process includes two successive examinations conducted under the sole auspices of the Army. Every man selected by the review board as fitting for military service is first subject to the departure examination (*visite de départ*) organized within the recruiting

⁹Men absent from the review board are considered as deemed fit for armed duty (Art. 30 of the Law [33] of 21 March 1905). Antoine Escalier was absent from the review board in 1908 and enlisted into the 44th Infantry Regiment in October 1908. His registration form (numbered 501 of the recruiting office of Tulle) contains a complete anthropometric description including an height of 162cm. Similar examples are François Michelou (registration number 790 from the recruiting office of Tulle) or François Vaux (registration number 831 from the recruiting office of Tulle).

office to assign men to the various military units. Those men who fail to pass this inspection are rejected (*réformés*) from the Army. The remaining ones must join within a few days their unit where they undergo a new examination, the enlistment examination (*visite d'incorporation*). Only those who pass this last examination end up being actually drafted for military service. The others are rejected from the Army.¹⁰

A crucial legal text for this sequence of two examinations is the *Instruction* [6] of 22 October 1905, on Physical Aptitude to Military Service. Particularly insightful is the fact that the text insists on the importance of recording height, though at this moment the Army is already aware of the height of the man when examined by the review board:

‘Young men deemed fit [by the review board] are allocated by recruiting office commanders to the different military units according to their physical and professional abilities (...). The main physical requirements are: height, ability to walk, horse riding abilities and capacities to handle heavy loads.¹¹ The first of these requirements (...) can be assessed using a graduation measuring rod; the determination of others is more complex and falls within the specific competence and sphere of responsibility of the military physician’.

The same text goes on with a statement on the physician’s field of intervention: ‘the physician gives his opinion on the physical aptitude at the review board and at recruiting offices, before enlistment. He also gives his opinion after the enlistment in the presence the commanding officer or during the regional commissions ruling military unit mutations’. This provides us with a clear summary of the sequence of the three examinations that men have to undergo: first at the review board, then within the recruiting office, and finally in their regiment once enlisted.¹²

¹⁰Cf. Colin [13], page 316; Rasmussen [39]; or Bertschy [7], page 208. Based on the *Statistiques Médicales de l’Armée*, Bertschy [7] computes a volume of men ‘excluded before being actually enlisted’ of 30 per 1000 every year until year 1901.

¹¹The quoted requirements were actually ranked in a previous version of this same text published in 1891: ‘first height and then ability to walk’ (see Section V page 76 of the *Instruction* [27] of 1891).

¹²Indeed the departure and enlistment examinations are particular instances of the general recommendation that every man should be examined when allocated to a new

In a nutshell, height is first taken when the man is examined by the review board, and this height is recorded in the recruitment table. After the examination by the review board, the Army retakes twice the height of men deemed fit by the review board for both selection and allocation purposes. These two new height measurements are made during the departure and the enlistment examinations.

4 The status of height in the registration form

If the height reported in the registration form is not a simple transcript of the height of the man when examined by the review board, then the constraint that the registration form should be created ‘as soon as possible’ after the review board by the recruiting office commander points toward a height recorded during the departure examination within the recruiting office.

Table 2 confirms that the difference between height in the registration form and height in the recruitment table does not merely reflect the difference in the populations covered in the two sources, with tall absentees alongside short exempted yielding the spread pattern in Figure 2. It restricts attention to men with a filled height in the recruitment table and the registration form. This 2,623 observation subsample thus excludes absentees and exempted men with only one height measurement. It is clear that a significant proportion of men still exhibit different heights in the two sources. In the sample of 2,616 men born in 1887, 498 men, *i.e.*, nearly 20 per cent of these men display different heights in the two sources. Height is more likely to differ in the two sources if there is a long time period elapsed between the selection by the review board in 1908 and the departure examination within the recruiting office: there are 30 per cent (75/257) of men enlisted in 1909 who display a different height in the two sources, against 15 per cent

unit (see art. 38 of the 25 November 1889 Decree [16]). We have few information about the actual operational process of the departure examination (see chapter 4 of Roynette [40]). The enlistment examination is better documented as a recent strand of research exploits the listed military aptitude criteria to discuss the emergence of military body hygiene (see, *e.g.*, Rasmussen [39]). A colorful description of the examination is given in a Louis Auguste Picard [35] novel: the men, on their arrival at the barracks, just receive a cap; they immediately undergo the ‘control of constitution’ where ‘every man who enters is examined from head to toes. Measured and weighed, it is the order of the minister’ (page 38).

Table 2: HEIGHT DIFFERENCES BETWEEN THE TWO SOURCES

	Number of men with height		
	completed in the two sources	identical in the two sources	different in the two sources
Initial sample	2,623	2,125	498
Men removed from the list	1	1	0
Men born before 1887	6	6	0
Men born in 1887	2,616	2,118	498
Men omitted from the list	4	2	2
Men called in 1908	2,612	2,116	496
Absentees	3	1	2
Examined by the review board	2,609	2,115	494
Volunteers	147	104	43
Enlisted in 1908	2,025	1,714	311
Exempted in 1908	89	41	48
Discharged in 1908	348	256	92
Enlisted in 1909	258	183	75
Exempted in 1909	84	69	15
Other	6	4	2

Reading: Out of 2,025 men enlisted in 1908 with a height completed in both the recruitment table and the registration form, height differs in the two sources for 311 men (so $2,025 - 311 = 1,714$ display equal height in the two sources).

(311/2,025) among those enlisted in 1908.

From now onwards, I build on this evidence to set the height in the registrations form as taken after the review board, during the departure examination. The data provides no information on the date of this examination, but it is known that it comes a few days before enlistment (Roynette [40], page 211), the date of which is reported on the registration form. Hence the date of the departure examination will be proxied by the date of the enlistment. More precisely, the height in the registration form is classified as follows:

1. The height of enlisted men is their height at enlistment.

This covers men enlisted in 1908, men discharged in 1908 and deemed fit in 1909, as well as the men exempted in 1908 or 1909 but enlisted following some recall during World War I.

Pierre Gautherie was 161cm tall during the review board. He is discharged in 1908 because of eczema. A form is created in 1908 following the discharge decision, with registration number 1049 from the recruiting office of Brive. He is not subject to the departure examination in 1908. He is exempted in 1909 and so he is neither subject to the departure examination in 1909. He is reexamined by the Army in the course

of the first recall wave occurring in December 1914 and eventually enlisted. The height of 163cm reported in his registration form is set as taken in 1914.

Item 1 covers the most common cases as men born in 1887 typically end up enlisted in 1908, 1909 or during the Great War. More specific situations are considered in Items 2 and 3.

2. The height of men exempted in 1908 or 1909 and once again exempted at the outcome of all recall waves is their height measured during the first recall in December 1914.

There are 47 registration forms on men exempted in 1908 and rejected at the outcome of recall waves; see, *e.g.*, Antoine Bouilhac (registration number 134 from the recruiting office of Brive). I set that the form is created following the first wave of recall in 1914. This should be seen as a conservative choice since the height coincides in the recruitment table and the registration forms for 45 men, *i.e.*, this amounts to set no individual height growth over a long period of time.

3. Corrected height is the height of the man at the moment of his last enlistment.

Men may be measured several times following enlistment, *e.g.*, if assigned to a new military unit or following a novel enlistment during the Great War several years after the 1908/1909 examinations. The Army then needs to update the height reported in the registration form according to item 1. This is done using the corrected height field of the form. The data only includes 104 corrected heights. One representative case is René Aupetit (registration number 1633 from the recruiting office of Tulle), discharged in 1908 with a short height of 154cm and a low weight of 48kg only, but deemed fit by the review board in 1909 and enlisted on October 7, 1909. His height in the registration form, taken in 1909, is still equal to 154cm. He is nevertheless rejected for ‘insufficient weight’ as of 12 October 1909, presumably at the outcome of the sequence of departure and enlistment examinations. When reexamined during the 1914 recall wave, he is considered as able and enlisted. The corrected height field is filled in his registration form, with a height of 158cm.

5 Descriptive statistics

I complement the initial 2,923 observation sample on men born in 1887 with the 104 completed corrected heights to get a consolidated 3,027 observation sample. In this sample the date at which the height taken in the registration form is only known for 2,857 observations. The height is completed in both the recruitment table and the registration form for 2,707 observations.¹³

Summary statistics about this 2,707 observation sample are given in Table 3. The men deemed fit in 1908 are about 4cm taller than the others. The men discharged in 1908 and enlisted in 1909 were also measured during the 1908 review board taller than the men exempted in 1909. A reverse pattern instead holds for height growth: the difference between the height at enlistment (recorded in the registration form) and the height taken during the review board in 1908 (recorded in the recruitment table) is lower for men enlisted in 1908 and the highest growth applies to exempted men. This is partly a consequence of the heterogeneity in the time elapsed between both examinations. Men exempted in 1908 or 1909 are first measured in 1908 and then during the Great War, which yields an age difference of more than 7 years, while men deemed fit in 1908 are enlisted around 6 months after their examination by the review board.

The total number of conscripts born in each locality of Corrèze between 1863 and 1901 in the full raw sample of registration forms from the *Archives départementales de la Corrèze* is used as a proxy for population density of each locality. Table 3 shows that men born in rural areas or small size villages and those born in the main cities (in the bottom and top quartiles of the population density distribution) are taller when measured during the 1908 examination by the review board and they experience a lower growth than the rest of the men. This U-shaped height pattern is reminiscent to the early stage of proto-industrialization where wood-input small-scaled mining activities located in sparsely populated areas coexist with the important weapons factory (*Manufacture d'Armes de Tulle*) operating in the main city of Corrèze since the 17th century (Quincy [37]).

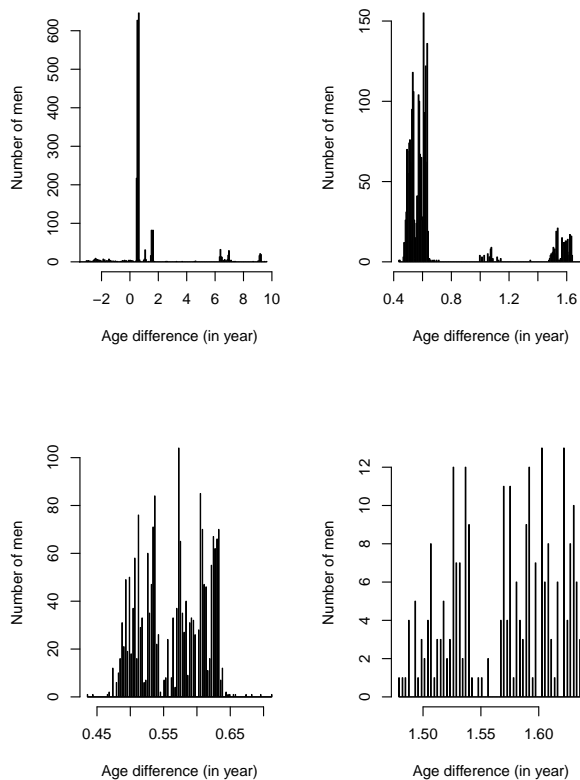
A more detailed information on age and height in this sample is reported

¹³The 2,707 observation sample size corresponds to the 2,612 men called in 1908 reported in Tables 1 and 2 with a filled height in the two data sources, plus 104 observations involving a corrected height, net of 9 observations where the date of the height measurement in the registration form remains unknown.

in Table 4. The height measurements on the same man are on average spaced by about a year. The review board examined the men born in Corrèze in 1887 in February, March and April 1908 when they were 20 or 21-year-old. The enlistment was usually occurring between October and December every year. This yields a period of time of approximately 6 months between the review board and the enlistment in 1908, and 18 months if enlistment happens in 1909, hence the average age difference of 1.1 year. More marginal cases are volunteers, who decide to enlist before the call (from the age of 16 years in the navy and 18 otherwise), which gives rise to a negative age difference, and also men recalled during the war (the initial active military service was for period of 2 years but the total duration of the service was 25 years). The top-left panel in Figure 4 depicts the whole distribution of age differences. The top-right panel focuses on the two main masses of men, formed by the men enlisted in 1908 or 1909. The two bottom panels of Figure 4 are zooms on each of these two categories. The Figure shows that the age difference heterogeneity comes from both the time of the examination by the review board (identical to all men born in the same county of Corrèze) and the time of enlistment.

The average individual growth over 1.1 year is 0.60cm. The range of variation in height in both sources (represented by ± 2 standard deviations around the mean) is about 22.4cm, which is a rather low figure compared to the one prevailing in modern populations.

We observe implausible extreme values of height growth at -11 cm and 23 cm. Negative height growth involves some volunteers: since they enlist before the call, their height in their registration form is often smaller than their height when examined by the review board (a negative height growth associated with a negative difference between the age at enlistment and the date of their examination by the review board reflects a positive growth experience). However in many cases such figures are likely measurement errors. Excess masses of men observed at levels of height thresholds required to enter specific military units are consistent with small height manipulations made during the departure examination within the recruiting offices for allocation purposes. The large discrepancies between the two height measurements are most plausibly due to errors made when height is measured during the review board (we find anecdotes on earlier cohorts where the man is lying or shod when measured) and/or when reporting height on the recruitment table.



The horizontal axis gives the age difference, *i.e.*, the time between the examination by the review board and the enlistment. The vertical axis gives the number of observations for every age difference. The top-left panel accounts for every age difference observed in the data. The top-right panel restricts to age differences of men concerned by an enlistment in 1908 and 1909. The bottom-left panel (resp., bottom-right) focuses on men enlisted in 1908 (resp., 1909). There are 71 observations with a age difference equal to 0.5342 year, *i.e.*, approximately 192 days.

Figure 4: AGE DIFFERENCE DISTRIBUTION

The last type of errors often occurs if the man is examined outside Corrèze since in this case his height has to be transmitted to the review board of Corrèze through a Prefectoral (civilian) channel. It is known that the review boards operating in the biggest cities were examining a very large number of men in a short period of time. For instance Roynette [40] computes an average individual examination lasting 38 seconds in the densely populated Seine department (which included Paris). Indeed, in the subsample of the 2.5 per cent lowest and 2.5 per cent highest reported height growth, we only find half of the men examined in Corrèze, and another third consists of recalled men measured during the war.¹⁴

For this reason, I will now focus on the 2,596 observation panel that discards the bottom and top 2.5 per cent per centiles of the height growth distribution. The resulting height growth distribution is shown in Figure 5; the right panel restricts to non-zero growth observations.

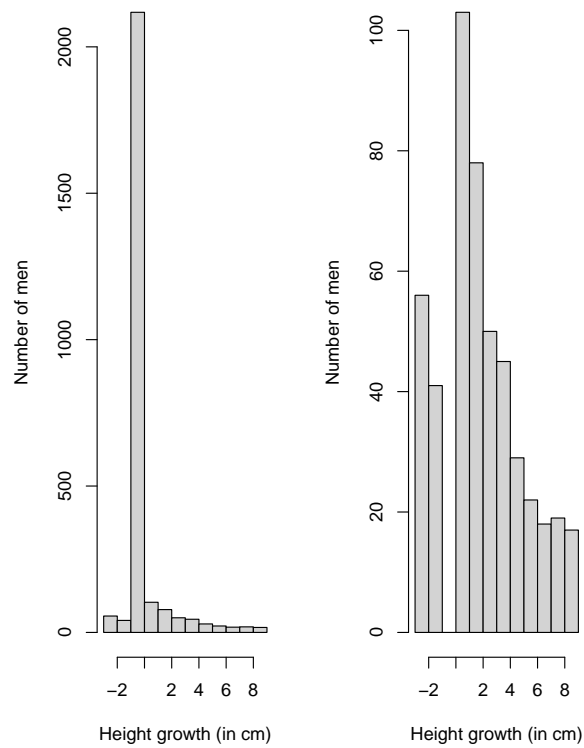
6 Estimating individual height growth

In order to estimate the individual height gain of men during the year following the examination by the review board, I first consider a standard fixed effects model where height h_{it} (in cm) of man i at time t (after his 20th birthday) is

$$h_{it} = \beta a_{it} + \gamma_i + \varepsilon_{it} \quad (1)$$

where a_{it} represents age of the man at time t , and γ_i captures individual (potentially non-observable) characteristics of the man, *e.g.*, some given genetic factors, family traditions or family wealth. The variable t is a time dummy that takes value 0 when the man is examined by the review board in 1908 and value 1 at the moment of his last measurement enlistment set according to the taxonomy given in Section 4, *i.e.*, at enlistment for most men. The linearity restriction in (1) is plausible as a first-order approximation over a short time window, but it seems less realistic over a longer period. It will be

¹⁴Philippe Teulade and Jean-François Vialat, both with a negative growth of -11 cm, were respectively examined in Melun and Versailles, two cities near Paris. Léon Vernéjoux, with a growth of 23 cm, was examined in Paris. All three were enlisted in 1908, *i.e.*, a few months after they appeared before the review board.



The horizontal axis gives the difference between the height in the registration form and the height in the recruitment table, which is set as accounting of height growth. The horizontal axis reports the number of observations for every height growth. The height is identical in the two sources for most men, which yields a huge mass of 0 height observations in the left panel. The right panel excludes 0 growth observations to highlight the empirical height growth distribution. Negative height growth apply to volunteers (who enlist before the examination by the review board) and measurement errors.

Figure 5: HEIGHT GROWTH DISTRIBUTION

relaxed in Section 6.3. By time-differencing (1) we get

$$\Delta h_i = \beta \Delta a_i + u_i, \tag{2}$$

where $\Delta h_i = h_{i1} - h_{i0}$ is growth of individual i (in cm) over the period $\Delta a_i = a_{i1} - a_{i0}$ (in years). As most men fall in Item 1 of the classification in Section 4, the age difference Δa_i is the time difference between the enlistment and the examination by the review board in 1908. The β coefficient gives the individual height growth (in cm) over the one-year period following the review board held in 1908.

6.1 OLS growth estimates

Various OLS estimates of the β coefficient are given in Table 5. In Column (1), which refers to the initial 2,707 observation panel, height growth of the man in the year following the review board is of 0.31cm. The high magnitude +23cm growth observations at the top of the height growth distribution in Table 4 suggests that this is an over-estimate of individual growth. Indeed the OLS estimate falls to 0.24cm in the 2,596 observation subsample in Columns (2) and (3) that excludes the 5 per cent extreme height growth observations. This is a very similar figure as in Quételet [36] benchmark for the annual growth of Belgian males between 20 and 25-year-old, born around 1850.

There is a (non-reported) negative correlation between OLS residuals \hat{u}_i and fitted height growth $\hat{\beta} \Delta a_i$ indicating that the OLS over-estimates (resp., under-estimates) the height growth of men enlisted earlier (resp., later), *i.e.*, the largest biases apply to volunteers and those recalled during the war. Robust standard errors clustered at the county of birth level are given in Column (3). The reported lower precision of the estimates shows that height growth dispersion is lower when assessed from a wide time window, which suggests less individual heterogeneity within volunteers and within first exempted and then recalled men than within men enlisted in 1908 or 1909.

A possible concern in the results obtained from the samples used in Columns (1) to (3) in Table 5 relates to the treatment of the more marginal populations identified in Section 4. In particular recall procedures pertain to men with specific characteristics that justified exemption, and they are imputed a very large sample window of several years to their growth episode. Estimates in Columns (4) and (5) apply to the more standard subgroups of

men enlisted in 1908 or 1909, thus excluding most volunteers and all recalled men. Men enlisted a few months after their examination by the review board in 1908 are assessed with a growth of 0.45cm over one year, while those first discharged in 1908 and enlisted in 1909 experience a lower growth of 0.29cm. Both estimates stand above the growth of 0.24cm obtained in the presence of volunteers and recalled men, implying a weaker growth in these two marginal groups.

6.2 IV growth estimates

The legally-based discharge decision made by the review board in 1908 relies on individual characteristics of men whose physical condition is assessed as fragile. The heterogeneity in the growth estimates across subgroups in Columns (4) and (5) of Table 5 shows that these characteristics are associated with a lower growth potential: a delayed enlistment applies to men who registered a lower growth than the average man over the same time window. That is, the men actually enlisted in 1908, in the fictitious situation where they would have been enlisted older in 1909 or later, would have registered a greater growth than those discharged/exempted in 1908 and actually measured in 1909 or later. In this case the endogenous enlistment/discharge/exemption decision made by the board, which determines the individual age difference in (2), makes the OLS an under-estimate of the true growth.

The date of the session of the review board can be considered as exogenous. In 1908, the municipalities of Corrèze are grouped into 29 counties. The order in which counties are visited must be chosen to minimize the review board travel costs: the sequence of examinations started from the county of Ayen on 18 February 1908, and ended with the examination on 13 April of men born in the county of Eygurande. Endogeneity of the age difference thus mostly comes from the enlistment date chosen by the review board, *i.e.*, the date of the last measurement rather than the first measurement taken during the examination by the review board.

To deal with this issue I rely on the person actually chairing the review board in 1908. Article 16 of the Law [33] of 21 March 1905 provides that the Chairperson must be the Prefect (*préfet*) of the department. But, if the Prefect is unable to be present, priority is given to the Secretary (*secrétaire général*) of the Prefecture of the department.

Georges Calmès is promoted Prefect of Corrèze in March 1905; the ‘second-class’ department of Corrèze is his first position as Prefect. His personal file held by the *Archives nationales* (reference F/1bI/450) suggests a possibly complex relationship he may have maintained with the Army. His mother indeed was from a military family, the names of some of them stood out etched into a pillar of the *Arc de Triomphe* in Paris. Following the defeat of France in the war with Prussia in 1871, in a context of revanchism, the young Calmès succeeds in entering in 1872 the high-level military school of Saint-Cyr training future officers for the armed forces. But he soon decides to resign, which seems to be a quite rare occurrence. Later he is exempted from military service; he is described as a short man, and during 30 years every internal administrative document emphasizes his poor health status as a strong constraint on the place where he can be employed.

Columns (1) and (2) in Table 6 report correlations between the age difference and the identity of the chairperson of the review board, either the Prefect Georges Calmès or the Secretary Charles Filhoulaud. In 1908 Filhoulaud replaces Calmès in 9 counties, out of a total of 29 counties. The Prefect appears much more willing to postpone the enlistment than the Secretary.

Columns (3) and (4) indicate that the correlation vanishes when one restricts attention to the separate subsamples of men enlisted in 1908 or those enlisted in 1909. This shows that the impact of the chairperson goes through the enlistment/discharge made in 1908 rather than the precise moment at which men are enlisted within a year; actually this moment mostly depends on the management of human resources policies of the recruiting offices.

The last two columns in Table 6 serve as robustness checks for the validity of the chairperson instrument. Column (5) shows that the presence of the Prefect is not based on the height taken during the review board, *e.g.*, the Prefect would choose to be present in poor counties where men are short and more likely to be discharged. Column (6) serves as a test for the mechanical effect that the Prefect would have been present during the first sessions of the review board only, implying a longer period of time elapsed between the review board and the enlistment. Here the explained variable is the duration (in year) between January 1, 1908 and the session of the review board. This duration is not correlated with the presence of the Prefect.

The estimation results of the two-step regression with an age difference

instrumented by the identity of the chairperson of the review board in 1908, either Calmès or Filhoulaud, are reported in table 7. Height growth over the year starting from the examination by the review board is revised upward from 0.24cm to 0.34cm (with a [0.29, 0.39] confidence interval). As expected, this is consistent with an OLS bias such that men enlisted later indeed display physical weaknesses associated with a growth weaker than the growth of the men actually enlisted earlier.

Column (3) of Table 7 is based on the consolidated subsample of all the men enlisted in 1908 or 1909; Table 6 has shown that the presence of the Prefect is not a valid instrument in the subsample of men enlisted in 1908 or in the subsample of men enlisted in 1909 considered separately. The higher growth estimate in this population tends to confirm the lower growth potential of exempted men called up for World War I, but the difference between the estimates in Columns (2) and (3) is only weakly significant.

6.3 A norm of reaction

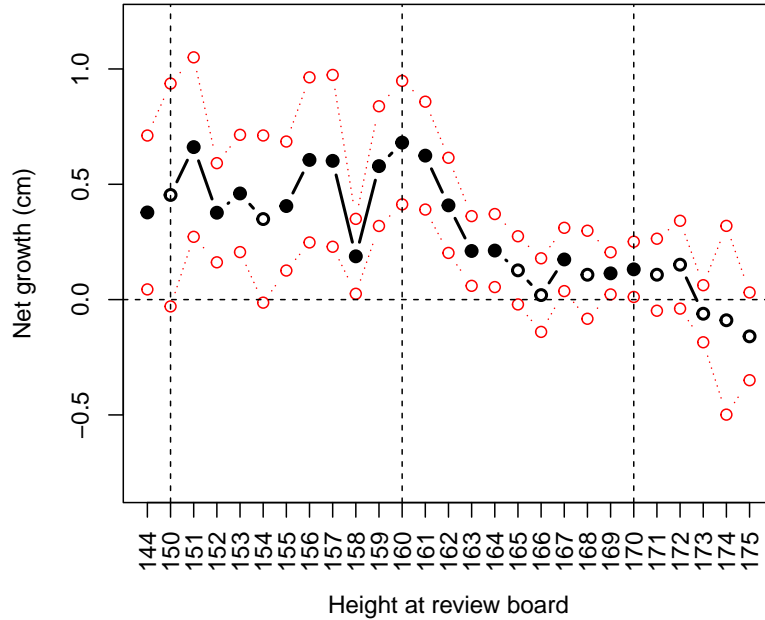
Life history theories deal with the role of environment on stature referring to the concept of norms of reaction. The compilation from cross-countries data made by McIntyre and Kacerosky [31] emphasizes the existence of two different regimes. In the first regime, a later age at maturity is associated with a shorter adult height. It mostly concerns traditional small-scale societies. The second regime, which applies to industrialized societies, instead entails both an early maturity and a taller final height. Bearing on these regimes, the fact that the median height of 163cm of the men born in 1887 in Corrèze is reached by boys between 13 and 14-year-old in the modern North American populations studied by Tanner and Davies [46] suggests that the economic development of the department was still lagging behind at the end of the nineteenth century.

This Section assesses the existence of a similar pattern within the cohort of men born in Corrèze in 1887, *i.e.*, whether poor men are subject to a slower tempo of growth and experience shorter final height than the rich. To this aim, I now reproduce the analysis made in Section 6.2 disaggregated at the level of clusters of men with the same height when subject to the first

measurement. The fixed effects model (2) now becomes

$$\Delta h_i = \sum_d \beta_d \Delta a_i \times \mathbf{1}_i^d + u_i \quad (3)$$

where $\mathbf{1}_i^d$ equals 1 if the height of conscript i is equal to d in the recruitment table, and 0 otherwise. Thus the parameter β_d gives the yearly height growth of men who were d cm tall when examined by the review board in 1908, starting from this examination.



Black dots have in the vertical axis the estimated height growth over one year of the men whose height taken during the examination by the review board of 1908 is reported in the horizontal axis. Height growth estimates are given in Table 9 in Appendix A. They rely on IV estimation, with the age difference (the time between the examination by the review board and the enlistment) instrumented by the identity of the head of the review board. Plain black dots apply to estimates significant at the 5 per cent level; black circles correspond to estimates not significant at this level. The red dots are the upper and lower bounds of the 95 per cent confidence intervals.

Figure 6: WITHIN-COHORT NORM OF REACTION

The estimation results, using the chairperson as an instrument for the age difference, are given in appendix A. They are summarized in Figure 6, with bold plain dots standing for growth estimates significant at the 5 per cent level. They closely resemble the pattern in the right panel of Figure 3. Late height growth appears decreasing with the height taken during the examination by the review board. Given the median height of 163cm during this examination, late growth concerns more than half of the cohort. This implies some catching-up after 20-year-old that contributes to reduce adult height inequality. Convergence is reinforced by the no-growth result of tall men: they already reached their final height when they are examined by the review board.

There is a lot of empirical evidence as of a similar catching-up in modern populations. For instance, in the post World War II populations covered in the longitudinal British standard Tanner-Whitehouse and the American National Center for Health Statistics data, late maturer boys (who experience late peak load velocity) continue to grow after 18-year-old while the average boy has achieved adult maturity (Tanner [45]).

The scarce evidence on historical populations also suggests that a late catching-up was part of historical growth processes. Indeed the pattern always occurs in Beeking and Kok [5], Gao and Schneider [23], and Thomson, Quanjer and Murkens [47] in the various populations they consider. Whether it was the last phase of prolonged growth trajectories, or a slow tempo of growth followed by a late rapid catching-up, is still subject to debate. The first alternative may be easier to reconcile with other demographic features (Thomson et al. [47]). The impressive mass of men concerned by positive late growth in Figure 6 accords with this view (see also item 2 in the concluding comments of this article).

In Beeking and Kok [5] late growth applies to the less well-off part of the sample. The picture of short men from Table 3 as being farmers from sparsely populated areas, with at most primary education, also points to the most economically disadvantaged groups in Corrèze. This gives rise to the announced within cohort pattern in line with the cross-country norms of reaction: tall rich men have reached adult maturity before 20 whereas maturity occurs later for shorter poor men.

6.4 Growth of absentees

There were 131 men absent from the review board. They are not included into our final data set since their initial height is missing and definitively lost. Many absentees were eventually retrieved by the Army and enlisted, often in 1908: Table 1 shows that the registration forms report the height of 89 absentees. Their average height is 164cm in the registration forms. It stands below the height of the men present at the review board (see Table 4). The norm of reaction pattern in Section 6.3 suggests that our assessment of the height growth of the man could consequently be slightly under-estimated. To get a quantitative evaluation of the possible bias due to these men, I have matched each of them with the man present at the review board with the nearest propensity score. The score is computed referring to the age of the man when examined by the review board in 1908, his height at enlistment and his county of birth. Absent men then are imputed the height at the review board of their nearest neighbor.

The imputed height of absentees is 163.11cm, with half of absentees' heights between 160 and 165cm. Reintroducing the absentees with their imputed height into the sample, one gets an augmented initial sample of 2,785 observations with a filled height in the two sources (rather than 2,707 in the previous Sections).

Table 8 shows that the small number of absentees does not have much of an affect on estimated growth. It tends to be magnified if one discards extreme height growth observations in the tails of the distribution, yielding an additional height gain of 0.1cm. In view of their short imputed height and the fact that many were enlisted in 1908, the height gain is even more pronounced when restricting to the standard case where enlistment occurs in 1908 or 1909, reaching 0.2cm.

7 Concluding comments

This article shows that the combination of two widely used data sources on conscription in France yields a longitudinal individual-level panel of French men around their 20s. The panel is used to assess height growth of a cohort of men born in an economically backward small rural area of France where most production may not transit through the market. There are two specific features associated with this cohort: it consists of men born within a

short period of time before the Great War, and the selection of conscripts by the review board was chaired by a Prefect showing a specific willingness to postpone enlistment. The first feature allows me to reach a quasi-exhaustive panel of men by exploiting recall procedures implemented in the course of the war. The second feature yields a relevant instrument to deal with endogeneity of the time difference between the two height measurements.

Still the small number of men who eventually fail to display two height measurements should not significantly alter the main results: the heavy, but feasible exercise reproduced on other cohorts of Frenchmen, born over the nineteenth century in other departments of France, would certainly valuable insights on the individual growth process.

In this line there are two interesting directions for further research:

1. The catching-up finding that only the shortest male population registers growth beyond 20-year-old applies to an economically backward region. An open issue is whether such patterns only occur if the economic disadvantage faced by young children is important enough. In line with the norm of reaction theories it could be that the shortest men no longer grow at 20 in the richer industrialized regions from north-east France.
2. A no-growth observation at 20 may reflect either the absence or some early catching-up arising before 20. In a climate of war preparation France decided to extend the duration of military service from 2 to 3 years in 1913. This implied a one-year anticipated call of men born in 1893, during the year following their 19s rather than 20s. The same timing was applied to the cohort of men born in 1894, but the war called for an even earlier enlistment of the subsequent cohorts during the year following their 18s. Exploiting the younger age of the last cohorts should allow us to sketch a final growth episode and possibly identify the precise age of adult maturity of the tallest men.

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Table 3: Summary statistics

	Observations	Review board height (cm)	Age difference (year)	Height growth (cm)
Military status				
Enlisted in 1908	2037	164.39	0.56	0.35
Exempted in 1908	231	160.29	7.79	1.99
Enlisted in 1909	268	161.10	1.57	0.56
exempted in 1909	97	160.18	7.20	0.76
Arrondissement of birth				
Brive	971	163.78	1.03	0.48
Tulle	1200	163.75	1.38	0.60
Ussel	539	163.53	0.94	0.80
Urban versus rural birthplace				
Village	747	163.87	1.11	0.61
Small-sized town	589	163.59	1.20	0.69
Medium-sized town	625	163.12	1.47	0.53
City	589	163.96	0.88	0.56
Education				
Can neither read nor write	242	162.02	1.67	0.43
Can only read	56	163.29	1.36	0.02
Can read and write	667	163.30	1.22	0.44
Primary education	1497	164.29	0.98	0.53
Intermediate education	48	163.21	0.41	2.56
Bachelor	53	164.11	0.97	2.60
Occupation				
Farmer	1482	163.64	1.33	0.41
Employee	541	163.90	0.99	0.71
Worker	347	163.16	0.92	0.65
Merchant	202	164.60	1.13	0.52
Soldier	52	165.94	0.89	0.13
Student	51	162.76	0.71	2.37
Senior executive	32	162.51	0.66	4.74

Note: The review board height is the one reported in the recruitment table.

The age difference is the time from the review board to the moment when height in the registration form is taken.

Height growth is the difference between height in the registration form and height in the recruitment table.

Reading: In the 2,707 observation sample there are 56 observations of men who can only read.

They are 163.29cm tall in the recruitment table, *i.e.*, when examined by the review board with the men of their county of birth.

On average they grow 0.02cm in height over 1.36 year from the review board.

Table 4: HEIGHT AND AGE DESCRIPTIVE STATISTICS

	Mean	St. Dev.	Minimum	First quartile	Third quartile	Maximum
Age at the review board (year)	20.708	0.290	20.145	20.459	20.953	21.277
Age at enlistment (year)	21.802	2.017	16.019	21.041	21.682	30.600
Age difference (year)	1.094	2.009	-4.907	0.526	0.630	9.647
Height at the review board (cm)	163.709	5.692	145	160	168	184
Height at enlistment (cm)	164.308	5.668	145	161	168	188
Height growth (cm)	0.599	2.696	-11	0	0	23

Number of observations: 2,707

Table 5: Quantifying height growth – OLS estimates

	Height growth (cm)				
	Robust county-clustered standard error				
	(1)	(2)	(3)	(4)	(5)
	Initial sample	95% subsample ^a	Enlisted in 1908 in the 95% subsample	Enlisted in 1909 in the 95% subsample	
Age difference (years)	0.306*** (0.022)	0.237*** (0.013)	0.237*** (0.019)	0.454*** (0.062)	0.291*** (0.067)
Observations	2,707	2,596	2,596	1,965	293
R ²	0.064	0.11	0.11	0.034	0.083
Adjusted R ²	0.064	0.109	0.109	0.034	0.08
F statistic	185.7	319.7	161.2	54.185	18.628

Notes: ***Significant at the 1 per cent level; ** 5 per cent level; * 10 per cent level.

a. This 2,596 observation subsample excludes the top and bottom 2.5% of the height growth distribution.
Reading: In the 2,596 observation sample, the OLS estimate of yearly individual growth is 0.237cm.

Table 6: Review board chair and delayed enlistment

	Age difference ^a (year)				Review board	
	(1)	(2)	(3)	(4)	height ^b (cm)	time ^c (year)
					(5)	(6)
	Initial sample	95% subsample	Enlisted in 1908 in the 95% subsample	Enlisted in 1909 in the 95% subsample	95% subsample	
Absent Prefect ^d	-0.290*** (0.081)	-0.278*** (0.084)	-0.020 (0.018)	0.021 (0.030)	0.348 (0.425)	0.019 (0.018)
Constant	1.371*** (0.064)	1.363*** (0.065)	0.566*** (0.010)	1.483*** (0.020)	163.729*** (0.218)	0.195*** (0.011)
Observations	2,707	2,596	1,965	293	2,596	2,596
R ²	0.004	0.004	0.019	0.002	0.001	0.033
Adjusted R ²	0.004	0.004	0.018	-0.001	0	0.032
F statistic	11.1	11.1	1.3	0.5	0.674	1.032

Notes: *** significant at the 1 per cent level; ** 5 per cent level; * 10 per cent level.

All robust standard errors (into brackets) are clustered at the county level.

a. The explained variable is the time between the examination by the review board and enlistment.

b. The explained variable is the height taken during the review board.

c. The explained variable is the time between 01/01/1908 and the examination by the review board.

d. The head of the review board is the Secretary Charles Filhoulaud rather than the Prefect Georges Calmès.

Reading: In the 2,707 observation sample, the time between the review board of 1908 and the enlistment decreases by 0.29 year if the review board is chaired by Charles Filhoulaud.

Table 7: Quantifying height growth – IV estimates

	Height growth (cm)		
	(1)	(2)	(3)
	Initial sample	95% subsample	Enlisted in 1908 or 1909 in the 95% subsample
Age difference (year)	0.464*** (0.052)	0.340*** (0.027)	0.428*** (0.047)
Instrument	Absent Prefect	Absent Prefect	Absent Prefect
Weak instrument test (p-value)	< 2.2e-16	< 2.2e-16	< 2.2e-16
Hausman test p-value	1.3e-06	1.15e-07	0.00162
Observations	2,707	2,596	2,258
R ²	0.047	0.089	0.039
Adjusted R ²	0.047	0.089	0.039

Notes: ***Significant at the 1 per cent level; ** 5 per cent level; * 10 per cent level.

All robust standard errors (into brackets) are clustered at the county level.

Reading: In the 2,707 observation sample, individual height growth over 1 year is 0.464cm with the time between the review board and the enlistment instrumented by the identity of the head Calmès *vs* Filhoulaud of the review board.

Table 8: Height growth of absentees– IV estimates

	Height growth (cm)		
	(1)	(2)	(3)
	Augmented initial sample	95% subsample	Enlisted in 1908 or 1909 in the 95% subsample
Age difference (year)	0.487*** (0.058)	0.434*** (0.033)	0.608*** (0.063)
Instrument	Absent Prefect	Absent Prefect	Absent Prefect
Weak instrument test (p-value)	< 2.2e-16	< 2.2e-16	< 2.2e-16
Hausman test p-value	5.59e-07	8.7e-14	1.1e-4
Observations	2,785	2,667	2,325
R ²	0.037	0.054	0.049
Adjusted R ²	0.036	0.054	0.048

Notes:

***Significant at the 1 per cent level; ** 5 per cent level; * 10 per cent level.

All robust standard errors (into brackets) are clustered at the county level.

Table 9: Assessing norms of reaction – IV estimates

	Height growth (cm)	Standard error	Number of men
(144,150]	0.378**	0.17	27
(150,151]	0.454*	0.246	13
(151,152]	0.661***	0.198	14
(152,153]	0.377***	0.11	23
(153,154]	0.46***	0.13	52
(154,155]	0.349*	0.185	52
(155,156]	0.406***	0.143	68
(156,157]	0.606***	0.183	76
(157,158]	0.602***	0.19	100
(158,159]	0.188**	0.083	119
(159,160]	0.579***	0.132	166
(160,161]	0.681***	0.137	164
(161,162]	0.624***	0.119	196
(162,163]	0.409***	0.105	225
(163,164]	0.211***	0.077	187
(164,165]	0.213***	0.081	160
(165,166]	0.127*	0.075	155
(166,167]	0.02	0.081	130
(167,168]	0.174**	0.07	122
(168,169]	0.108	0.097	100
(169,170]	0.114**	0.047	111
(170,171]	0.131**	0.061	107
(171,172]	0.108	0.08	66
(172,173]	0.151	0.097	44
(173,174]	-0.061	0.063	41
(174,175]	-0.089	0.209	27
(175,184]	-0.159	0.097	51
Instrument	Absent Prefect		
Observations	2596		
R2	0.084		
Adjusted R2	0.075		

Notes: ***Significant at the 1 per cent level; ** 5 per cent level; * 10 per cent level.
All robust standard errors are clustered at the county level.