

Protectionism and the Education-Fertility Trade-off in Late 19th Century France

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Abstract

The assumption that education and fertility are endogenous decisions that react to economic circumstances is a cornerstone of the unified growth theory that explains the transition to modern economic growth, yet evidence that such a mechanism was in operation before the 20th century is limited. This paper provides evidence of how protectionism reversed the education and fertility trends that were well under way in late 19th-century France. The Méline tariff, a tariff on cereals introduced in 1892, led to a substantial increase in agricultural wages, thus reducing the relative return to education. Since the importance of cereal production varied across regions, we use these differences to estimate the impact of the tariff. Our findings indicate that the tariff reduced education and increased fertility. The magnitude of these effects was substantial, and in regions with large shares of employment in cereal production the tariff offset the time trend in education for up to 15 years. Our results thus indicate that even in the 19th century, policies that changed the economic prospects of their offspring affected parents' decisions about the quantity and quality of children.

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Key words: Education, fertility, unified growth theory, protectionism, France.

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1 Introduction

The causes of the emergence of modern growth remain hotly debated amongst economists. One of the most influential theories is unified growth theory (from now onwards, UGT), developed by Galor and Weil (1999), Galor and Weil (2000) and Galor and Moav (2002), which proposes a mechanism through which economies move endogenously from a subsistence Malthusian economy into a regime with growing per capita incomes. UGT builds on two key elements. On the one hand, technological change depends on population size and the level of education of the labour force. On the other, population growth and education are determined by household choices which respond to economic incentives. This second element implies a trade-off between the quantity and the quality of children that an individual has, with parents choosing between numerous but little-educated children or a few well-schooled offspring. Critics of UGT argue that it is unlikely that in the 19th century fertility and education were the outcome of rational choices, and that they were more likely to be shaped by social norms than by economic constraints.¹ The aim of this paper is to provide evidence for the fact that economic shocks affected fertility and education decisions well before the postwar period.

Our identification strategy relies on a major policy shock that occurred in France at the end of the 19th century. Following a massive increase in cereal exports that were arriving to Western Europe from the Americas and Russia, cereal prices in France plunged, resulting in a major income loss for cereal producers. As was the case in other European countries, political pressure to impose tariffs on cereal imports grew in the 1880s and led to the adoption in 1892 of the so called Méline tariff, a tariff that halted the fall in cereal prices and led to substantial wage increases (O'Rourke 1997). We argue that, under the assumption that human capital is less productive in agriculture than in manufacturing, the tariff reduced the relative return to education and, as predicted by UGT, led to a reduction in human capital investments and an increase in fertility. It is important to point out that we do not claim that the Méline tariff triggered the demographic transition in France, which had already taken place. Rather, we examine whether an economic shock affects quantity-quality choices at a point in history for which it is well established that households had taken control over their fertility decisions.

We construct a simple model that captures the quantity-quality trade-off. Our economy has two sectors, agriculture and manufacturing, and we suppose that human capital is productive only in the latter. Parents derive utility from both the number of children that they have and from the expected income of their offspring, which generates the usual trade-off between

¹See Guinnane (2011), Diebolt (2015) and Clark and Cummins (2015) for a discussion.

fertility and investment in children's education. The latter is in turn determined by the relative return to education, that is, by the wage in manufacturing relative to that in agriculture and by the probabilities of being employed in one or the other sector. A tariff on agricultural goods increases wages in farming and the employment share of the sector, thus reducing the return to education and leading to lower investments in human capital. Because parents spend fewer resources in children's quality, they respond by increasing their quantity, and the tariff results in higher fertility rates. The larger the initial share of employment in cereal production, the stronger these effects are since the price increase implied by the tariff represents a large shock to the local economy.

To take the model to the data we use France's division into administrative districts. In the late 19th century, these districts differed greatly in the importance that agriculture, and in particular cereal production, had in the local economy. We construct a measure of employment in cereal production as a share of total employment for 1892 and interact it with a dummy taking the value one whenever the Méline tariff was in operation. We then examine the effect of the tariff on birth rates and fertility rates, and find a positive impact of the dummy interacted with cereal employment shares which is consistent with the theory. Education is measured by enrolment in primary education, which at the time was supposed to cater for children aged between 6 and 13. Enrolment rates were negatively affected by the tariff, supporting theories that maintain that both education and fertility react rapidly to economic incentives, and that such responses took place even in the 19th century.

The paper contributes to the literature concerned with identifying the determinants of parental choices between fertility and education. The model introduced by Becker (1960) and enriched by Becker and Tomes (1976) has been the subject of numerous empirical tests. Most of this literature has used contemporary data and a variety of identification strategies, such as considering the impact of the arrival of twins in a household on subsequent education investments; see Rosenzweig and Wolpin (1980) or Rosenzweig and Zhang (2009) for more recent data. Broadly speaking, the evidence supports the existence of such a trade-off in the second half of the 20th century, although some results are less supportive (notably Black, Devereux, and Salvanes (2005) who argue that the impact of family size on education is in fact a relationship between birth order and education).

In contrast to the numerous studies on recent data, historical evidence on this trade-off is scarce, the exceptions being Becker, Cinnirella, and Woessmann (2010), Bleakley and Lange (2009) Diebolt, Mishra, and Perrin (2015), Diebolt, Menard, and Perrin (2016) and De La Croix

and Perrin (2016). Our analysis shares much with these papers. Becker, Cinnirella, and Woessmann (2010) identify the quality-quantity trade-off using data for 19th century Prussia; they find suitable instruments for regional differences in education and fertility (sex ratios and distance to Wittenberg) and can hence identify the impact of one variable on the other. Our work is particularly close to Bleakley and Lange (2009) who use disease eradication in the south of the US around 1910 to analyse fertility and education responses. The exogenous campaigns to eradicate hookworm, a parasite that particularly affects children’s health, reduced the “price of child quality” and thus increased the return to human capital. As a result, educational investments rose and fertility rates fell. We follow a similar empirical strategy by focusing on the relative return to education. In contrast to Bleakley and Lange (2009), the external shock we consider has a less direct impact on children’s welfare and rather acts by changing equilibrium prices and quantities in the economy. What makes the strength of Bleakley and Lange’s paper is also its drawback. Because it relies on a shock that has a direct impact on children’s quality, the mechanism in operation is well identified, yet it does not provide evidence that aggregate macroeconomic features impact fertility and education as advocated by UGT. Our analysis focuses precisely on a major aggregate shock and identifies its consequences for fertility and education.

Three recent articles have used French district-level data similar to the one in this paper. France is an interesting case to study, not only because it has rich historical data, but also since it was the first country to experience the fertility transition, well before any of the other early industrialisers. Diebolt, Mishra, and Perrin (2015) and Diebolt, Menard, and Perrin (2016) are concerned with identifying the quantity-quality trade-off. Using a number of instruments, they find a trade-off between fertility and education and identify a causal impact of the former on the latter, thus providing evidence for the mechanisms behind UGT. Furthermore, their analysis of gender differences in schooling indicates that the rise in female educational endowments played a role in the fertility transition. De La Croix and Perrin (2016) use the same data but take a different approach by building a detailed model of the determinants of education and fertility. As is the case in our paper, their approach is well-grounded in the theory but rather than using the latter to inspire a reduced-form estimation, as we do, they perform structural estimations aimed at quantifying to what extent observed patterns can be explained by rational choice rather than social norms. They estimate the deep parameters in the model and conclude that the rational-choice model can account for about a third of the fertility variation across districts and over time, while it explains between 71 and 83 percent of the dispersion of primary school enrolment.

Both articles indicate the importance of the quantity-quality tradeoff in France during the 19th century. The contribution of our paper is to examine to what extent these decisions reacted to an aggregate economic shock. By showing that fertility and education responded in opposite directions we provide further support for the existence of a trade-off, by identifying a rapid reaction to the policy our results indicate that rational-choice considerations must be behind such changes since social norms are unlikely to evolve so fast.

The paper is also related to a vast body of evidence trying to identify the determinants of the demographic transition; see Easterlin (1976) for a discussion. Although our analysis is not concerned with this episode, since France had the world's earliest demographic transition which took place almost a century before the Méline tariff was introduced,² some of this literature proposes an approach closely related to ours by trying to identify variables that affect the cost of having children. Notably, Schultz (1985) argues that the fertility transition in Sweden, which took place in the 1880s, was largely the result of changes in international agricultural prices that raised the relative wage in female-intensive occupations. Exploiting differences across Swedish counties in the intensity of these activities, he finds that the increase in relative female wages explains a substantial fraction of fertility changes. Our paper shares with this work its emphasis on how terms of trade shocks that affect relative wages in a country can lead to rapid fertility responses. Murphy (2015) explores French fertility using regional data for the 19th century, and his findings indicate the importance of education, particularly that of females, but also of cultural factors.

Lastly, the paper is related to the economic history literature documenting the impact of late 19th century protectionist policy on economic outcomes. Following Bairoch (1972), numerous studies have found that protectionism was associated with higher growth rates and, when systematized to a panel of countries, this positive association between growth and tariffs has generated the so-called tariff-growth paradox; see O'Rourke (1997), O'Rourke (2000), Jacks (2006) and the survey in Lampe and Sharp (2013). Here we take a different approach; rather than exploiting cross-country differences, we document that *within* France the districts that benefited the most from the tariff were also those where it had the strongest negative effect on children's education.³

The paper is organised as follows. Section 2 gives the historical background of our study in terms of agricultural protectionism, education decisions and fertility. Section 3 solves a two-

²See Chaunu (1972), Van de Walle (1980), Weir (1984) and Bardet and Le Bras (1988) for evidence.

³Dormois (2009) uses industry-level data to document the negative impact of industrial tariffs on European industry.

sector model of the joint family decision between the number of children and education. Section 4 presents the econometric specification we use to bring the model to the data. The next two sections present the data and the empirical results. Section 7 concludes.

2 Historical background

2.1 The Méline tariff and its economic consequences

The signing of the 1860 free-trade treaty with England has been viewed as a milestone in the historiography of French attitudes towards international trade (Bairoch 1972). Recent research argues that economic forces largely anticipated trade politics; see Nye (1991), Accominotti and Flandreau (2008), and Tena-Junguito, Lampe, and Tâmega Fernandes (2012). Nye (2007) shows that effective tariff duties on imports were low in France throughout the century, especially on agricultural products. The invention of the steamship and the development of the domestic railway network triggered a decrease of freight rates, especially across the Atlantic (North 1958 and Harley 1988) that increased grain market integration; see Federico and Persson (2007) and Uebele (2011). The resulting boom in trade was mainly driven by large exports of grains and other primary products from Latin America to Europe which resulted in deflationary pressure on prices in France; see Kindleberger (1950). Agricultural prices declined more than other prices, thus reducing farmers' revenues, and generalised discontent led farmers to lobby for protection although, because of the alliance between free-traders and industrialists, no majority was obtained in Parliament to impose protective tariffs; see Dormois (2012).⁴

The 1889 parliamentary elections tilted the population of lawmakers towards a majority in favor of more protection. Negotiations with the governments and discussions in Parliament led to the proposal of an increase in the tariffs on cereals to fight the competition coming from the Americas.⁵ Tariffs were introduced *ad valorem*: for each 100 kilos of cereals, the tariff increased the import price by 5 francs in 1892, which amounted to about 25% of the import price (see 1 below and Golob, 1944, p. 204). The economic magnitude of the tariff was substantial. Levasseur (1911, vol. II, p. 585) estimates that the Méline tariff, if applied earlier, would have increased the cereal prices in 1889 by 80%. Moreover, the law allowed for the tariff to be adjusted every

⁴Farmers' lobbying in the 1880s only led to the introduction of two different tariffs on wheat, depending on whether the country of origin of the product was granted the 'most-favored nation' clause or not. All of France's major trading partners were granted this clause, see Bassino and Dormois (1972).

⁵The tariff is named after Jules Méline, MP, several times agriculture minister and Prime Minister from 1896 to 1898. Méline, a staunch defender of agriculture, proposes to parliament the adoption of a tariff on cereals, which once adopted it becomes known as the "Méline tariff". Méline justified the increase of the tariff by saying to lawmakers that "suddenly came the development of the means of transportation and communication, the rapid decrease in freight costs, in a few years placing these great markets [i.e. America, India and Australia] at our door"; quoted in Golob (1944, p.182)

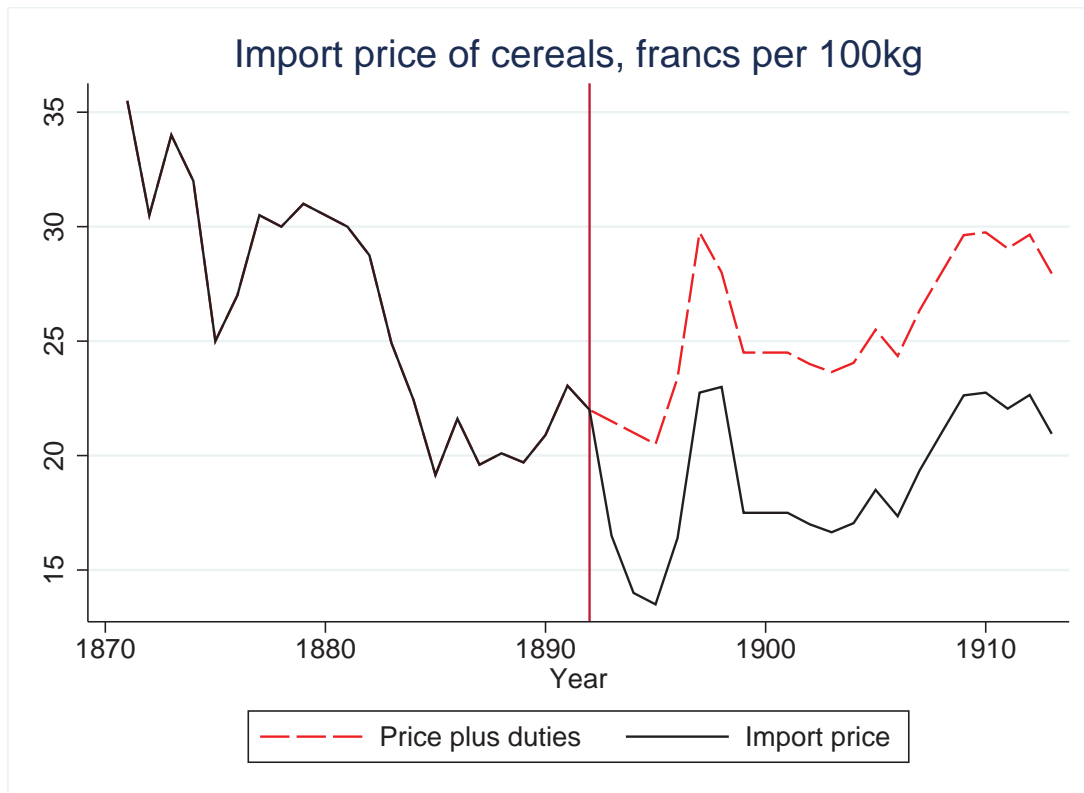


Figure 1: Cereal price in France, 1872-1913

year to take into account variations in the world price of cereals. According to Augé-Laribé (1950, p. 246-7) and Golob (1944, p. 234) there were thirty major legislative modifications of the tariff structure of 20 years. For example, in 1894 the wheat duty was increased from 5 to 7 francs per hundred kilograms, and in general was responsive to the underlying import price during the twenty years that followed the adoption of the Méline tariff.

Figure 1 depicts the evolution of the price of cereals over our period of interest. Between 1871 and 1891 the import price of cereals had fallen by 35%, reaching a value of 22 francs per 100 kilos by 1892. The import price continued to fall in the years immediately following the introduction of the tariff, with the lowest price being reached in 1895. With an import price of 13.5 francs that year, the 7 franc tariff implied a massive increase in the market price of cereals. Over the following two decades, import prices fluctuated around 19 francs, with the duties increasing the price by an average of 37 percent and substantially stabilizing the domestic price.

The magnitude of the effects of the tariff was enormous. In a context in which the world price of grains decreased by a third, economist Daniel Zolla (1903, p. 26-33) noted that the tariff "succeeds in limiting the reduction in prices compared to England or Germany". For

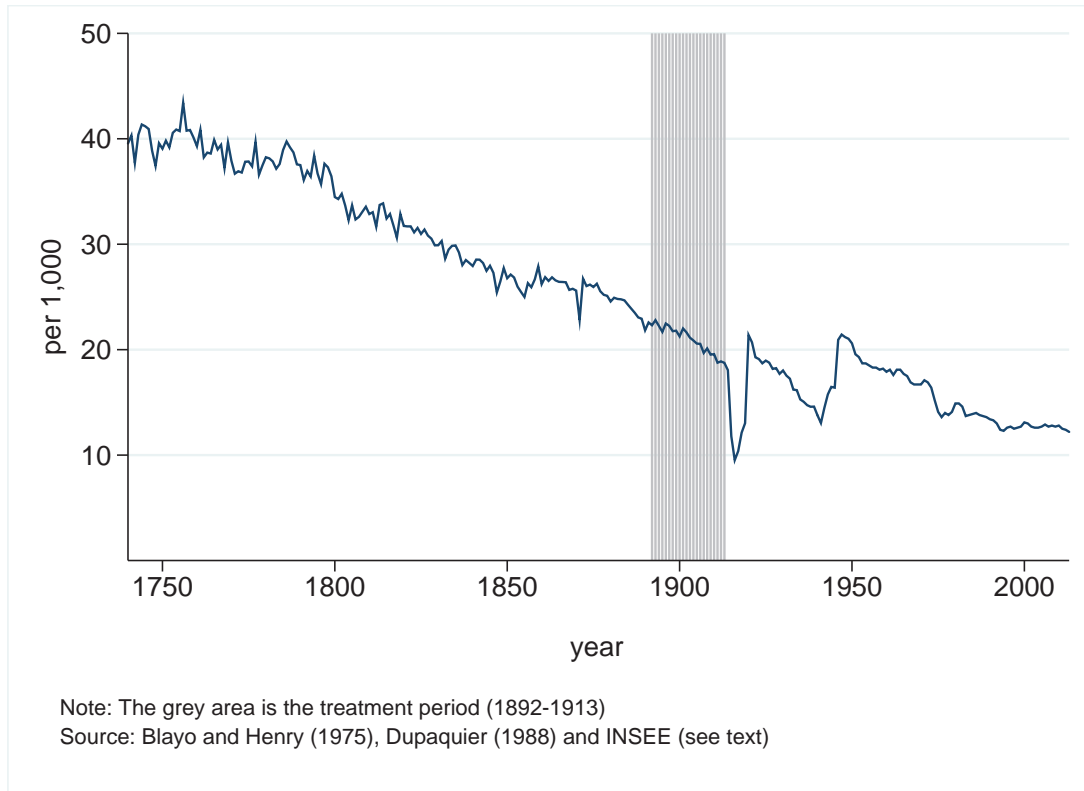


Figure 2: The birth rate in France 1740-2013

example, Zolla computes a price difference equal to half of the price in London for wheat (after 1892, the price levelled at 10 francs in England against 15 francs in France, cf. p. 28). Using a model that allows him to construct a counterfactual with free trade in cereals, O'Rourke (1997) documents that the Méline tariff protected farmers revenue from most of this decline by increasing domestic prices by 26.5%. In a country in which the agricultural population represented 50% of the working population (Golob, 1944, p. 18), the tariff implied that actual French grain output was twice as large as it would have been in the absence of protection. The overall effect of the reduction in world prices plus the tariffs was an increase in the average real wages, largely driven by the wages of farmers who were made better off compared to the rest of the population (see also Zolla, 1903).⁶

2.2 Education, fertility and the demographic transition in France

As it is widely acknowledged, France was the first country to experience a fertility transition; see Guinnane (2011) for a discussion in an international context. Figure 1 depicts the crude birth

⁶The impact of tariffs during the 19th century on wages and income is a complex question. See, for example O'Rourke (2000) and the survey in Lampe and Sharp (2013).

rate in France over the period 1740 to 2012, with our period of interest (1872-1913) shaded.⁷ The first few years in the sample exhibit the usual pre-transition birth rate of around 40 children per thousand individuals. Birth rates started to decline around 1790, almost one century before the fertility transition took place in England and Germany. The reasons for this early transition are still poorly understood. It has been argued that the unique and spectacular reduction in mortality that took place in France in the second half of the 18th century could be a trigger, while other authors have emphasised the role of wealth and the changes in inequality that followed the French Revolution; see Wrigley (1985a, 1985b), Guinnane (2011), and Cummins (2013) amongst others. In contrast to other countries, where the late 19th century witnessed major changes in fertility behaviour, the period just before the introduction of the Méline tariff consists of two decades of substantial stability, with birth rates in France continuing their long-run trend, as can be seen from figure 2. There is nevertheless a slowdown of the trend after 1892. The birth rate fell by 2.5 children between 1872 and 1882 and by 1.9 children in the next decade (reductions of 1 and 0.75%, respectively), yet in the decade following the introduction of the tariff the birth rate declined by only 0.7 children (i.e. by 0.3%). Fertility changed momentum after World War I, falling by 2.5 children between 1924 (the year in which the birth rate returned to its pre-war level) and 1934.

Figure 3 uses our district-level data to compute national aggregates for crude birth rates and enrolment rates (see section 4 for the details). The change in the birth-rate trend is apparent here. The rapid decline over the previous two decades comes to a halt, with birth rates increasing slightly just after the introduction of the tariff before declining again, although at a slower pace.

Turning now to the schooling, the expansion of education in France took place in the middle of the 19th century, the result of major legal changes and a substantial investment in education infrastructure; see Prost (1993). Historians of education describe the period 1837-1867 as a period of “universalization” of primary education (Furet and Ozouf 1977; Grew and Harrigan 1991). The Guizot law of 1833, and the Duruy law of 1867, officially organised primary education by requiring any agglomeration of more than 500 inhabitants to open, respectively, a boys’ and a girls’ primary school, introducing a minimum wage for teachers, and facilitating access to schooling by the children of households that were unable to afford school fees. As a result, by the time the Ferry laws were introduced (1881-1882) to implement compulsory and free private education, a majority of districts had attained enrolment rates close to one hundred percent. A

⁷Blayo and Henry (1975) is the source of the series before 1800. The 1946 INSEE statistical yearbook gives 19th century numbers, with the corrections proposed in Dupaquier (1988). The digitized series on the INSEE website are the source of figures for the 20th century.

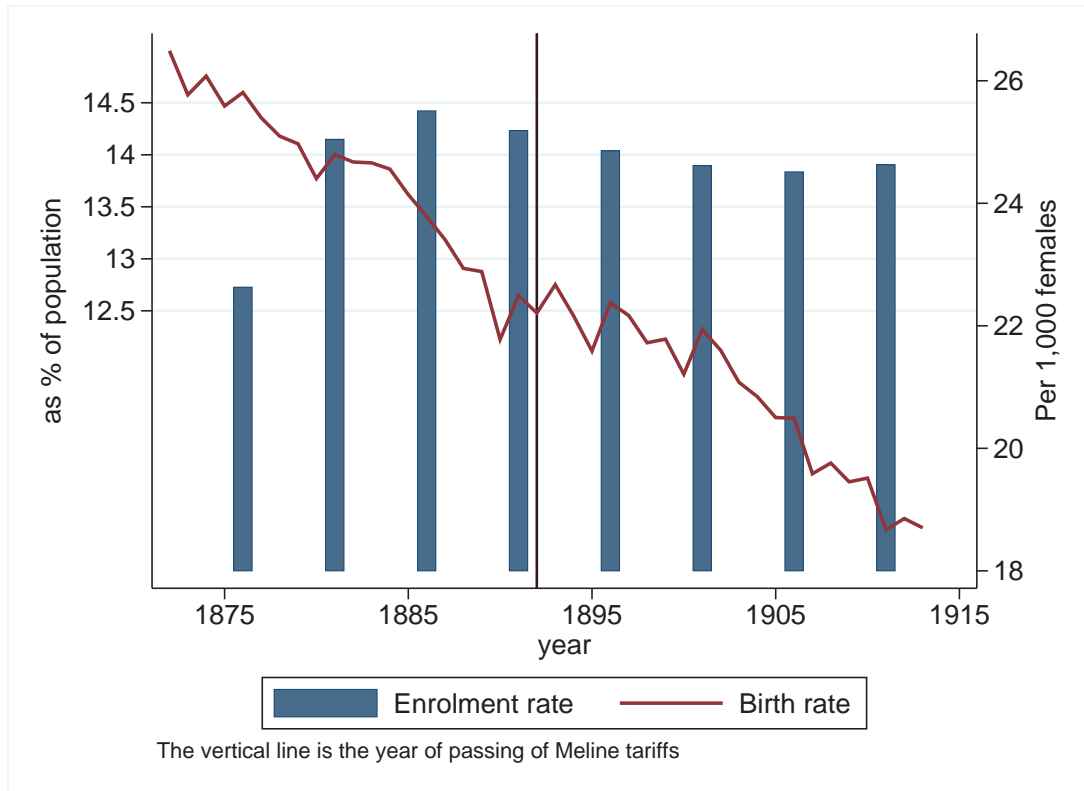


Figure 3: The literacy and the fertility rate, France 1872-1913

puzzle in the literature is that of the “lost decade”. Between 1886 and 1896 not only there is no progress in primary schooling, but many districts experienced a decline in enrolment rates, with the average falling by 3.9% and 4.4% for boys and girls respectively; see Prost (1993, p 71). The timing of these changes raises the question of whether the Méline tariff was one of the factors behind them.

Figure 3 presents one of our measures of education, enrolment rates in public and private primary schools, defined as number of pupils aged 6 to 13 enrolled over the total population of children aged 6 to 13 (see below for the details). Enrolment rates increased before the passing of the tariff, but the puzzle noticed by Prost (1993) is apparent, as the enrolment rate of children aged 6 to 13 decreased from 1891 to 1901, only to recover in 1906.

2.3 The returns to education

A key assumption underlying the mechanism that we will explore is that the return to human capital was higher in manufacturing than in agriculture in late 19th century France. Unfortunately, we have no direct measures of these returns as individual data on wages and education over the period is not available, but a number of elements point towards this being a reasonable hypothesis.

Data on education by sector of employment are scarce, and the earliest figures we have been able to find correspond to 1906. They indicate that even at this time, lacking education was substantially more common amongst those working in agriculture than in manufacturing: illiteracy rates for females were 8.4 percent in manufacturing and almost double amongst those employed in agriculture (15.6%), for men they were 9.2 percent and 12.6 percent, respectively.⁸

Table 1 presents evidence on the urban-rural wage gap during our period of interest, defined as the ratio of the nominal wages in the two types of location for salaried males. We consider wages paid for (unskilled) farm-related work as the nominal wages in rural areas. Wages paid to unskilled workers in urban areas are those paid in the capital city of the region. Table 1 presents two levels of aggregation of the wage gap. The finest level is at the *département* level. As a robustness check, we also present the wage gap between the capital city of the region (which grouped 4 to 5 *départements*) and the average paid in the countryside of the region. Lastly, we report the wage gap computed using wages averaged at the national level.

The wage gap at those three levels of aggregation exhibited a similar evolution. The regional figures indicate that there was a moderate gap of 10% around 1850, which grew sharply in the following decades and stabilized around 50% in the late 19th and early 20th century. The *département* data exhibits a lower wage gap, which is explained by the fact that wages in the *département* capital cities were on average lower than wages in the regional capital cities. The national data also shows a slow decrease in the wage gap after the introduction of the tariff. This large difference is difficult to justify simply by the cost of mobility and the cost of living, and is likely to have been due to differences in human capital across the two sectors.⁹

	1852	1882	1892	1896	1900	1906	1911
Département	0.99	1.18	1.29				1.27
Regional	1.1	1.29	1.48				1.51
National			1.53	1.43	1.48	1.45	1.41

Source: Département and regional: Sicsic (1992, p. 685); National: Simiand (1931, table 1).

Table 1: The urban/rural wage gap ratios

The likely explanation for the low educational achievement of the French agricultural labour force is the relative technological backwardness of the sector during the 1870–1913 period. Although the reverse hypothesis has been proposed, explaining the low productivity of the agricul-

⁸The data are from the *Annuaire Statistique de la France*, 1910, and are reported by Chanut, Heffer, Mairesse, and Postel-Vinay (1995). See also Furet and Ozouf (1977).

⁹See Chanut, Heffer, Mairesse, and Postel-Vinay (1995) for further discussion of wages in France in the 19th century.

tural sector by the lack of education of French peasants (Barral 1968; Weber 1976) or their low appetite for technological progress (Barral 1968), recent work maintains that it was due to the lack of agricultural investment (Postel-Vinay 1991; Grantham 1993; Postel-Vinay 1998). Male labour productivity in French agriculture was only 60% of that in England in 1880, and that it had grown to 72% by 1910, a modest catch-up; see Bairoch (1965) as well as more recent studies (O'Brien and Keyder 2011). Dormois (1996) shows that during the 1890-1910 period, France had the fourth lowest average increase of agricultural productivity of the developed world, far behind Germany or the Scandinavian countries. The yield per hectare in wheat production was twice as low in France as in all other European countries except Russia and Italy (Bairoch 1989). Yet it is important to emphasize that this pattern was not prevalent in all of Europe, since in some countries technology had made rapid inroads into the agricultural sector, thus increasing the demand for educated farm workers.¹⁰

3 Modelling education and fertility decisions

In order to understand the way in which tariffs affect fertility and education investments, we consider a two-sector version of the quantity-quality trade-off model developed by Galor and Weil (1999) and Galor and Weil (2000) that abstracts from technological change. The production side of the economy features two goods, an agricultural good and a manufacturing good. The latter is the numeraire, while the agricultural good is traded and has an exogenously given price p_t that will be the source of the shock we consider. As in the original model, the key decision is the choice by households of the number of children and their education, i.e. their quantity and quality, in response to economic incentives.

3.1 Technologies and preferences

The economy produces two goods, an agricultural good and a manufacturing good. The former is produced using land T and labour L_{at} according to the following technology

$$Y_{at} = (AT)^{1-\alpha} L_{at}^\alpha, \quad (1)$$

where Y_{at} is agricultural output, A is agricultural productivity, and $0 < \alpha < 1$. The manufacturing good is also produced through a Cobb-Douglas technology of the form

$$Y_{mt} = K^{1-\alpha} (h_t L_{mt})^\alpha, \quad (2)$$

¹⁰See Golob (1944) on the technological backwardness of French agriculture, O'Brien and Keyder (2011) on a comparison between France and England, and Henriksen, Lampe, and Sharp (2011) for a study of the Danish experience.

where Y_{mt} is manufacturing output, K is a fixed factor in the sector (potentially capital, but we abstract from its accumulation), h_t the average human capital of workers and L_{mt} employment in the sector. The price of the manufacturing good is 1, while that of the agricultural good is p_t and will be the source of the shock we consider. A crucial assumption in the model is that human capital increases productivity in the manufacturing sector but not in agriculture. Although this is an extreme assumption, it is intended to capture in a simple way the idea that the return to education was higher in manufacturing.

The two sectors pay workers their marginal product, and in the appendix we derive the agricultural wage, w_{at} , and the wage per efficiency unit of labour in manufacturing, w_{mt} . Under our assumption that education has no impact on agricultural productivity, the income of a farmer is simply w_{at} . In contrast, human capital increases manufacturing productivity, implying that an agent with h_t efficiency units of labour receives a potential income of $h_t w_{mt}$. Labour market equilibrium requires the equalization of incomes across sectors, i.e. $w_{at} p_t = h_t w_{mt}$, and yields the fraction of the population employed in agriculture q_t and that employed in manufacturing $1 - q_t$.

We turn next to households' preferences and constraints. Agents live for 2 periods, in the first one they are born and receive education from their parents, in the second they are adults and are endowed with 1 unit of time, which they may spend working or raising children. Borrowing across periods is assumed not to be possible.

We suppose that the utility of an agent born at time t is given by

$$U_t = c_t^{1-\gamma} (n_{t+1} E y_{t+1})^\gamma, \quad (3)$$

where c_t is the lifetime consumption of the individual, n_{t+1} the number of children she has (which are born at $t + 1$) and $E y_{t+1}$ the expected (potential) income that her offspring (born at $t + 1$) will get when she is an adult. The time cost of bearing n_t children is given by $\tau^q n_t$, while $\tau^e e_t n_t$ is the time cost of giving them a level of education e_t . The budget constraint is then given by

$$c_t = y_t (1 - (\tau^q + \tau^e e_{t+1}) n_{t+1}),$$

where y_t is the potential income when the individual is an adult. We suppose that a constant fraction of consumption is allocated to the agricultural good and the rest to the manufacturing good.¹¹

Adults whose parents invested e_t in their education have a level of human capital $h(e_t)$ with

¹¹It would be straight forward to derive such a result from a Cobb-Douglas utility function with two goods. We abstract from such decision in order to concentrate on the key aspects of the model.

$$h(e_t) = \beta e_t^\theta, \quad (4)$$

where $\beta > 0$ and $\theta \in (0, 1)$, implying that $h(e_t)$ is increasing in e_t and exhibits diminishing returns to the education investment. When taking the education decision of their children, parents suppose that with probability q they will work in agriculture and with probability $(1 - q)$ in manufacturing. The resulting expected potential income of an adult born at t is

$$Ey_t = q_{t+1}w_{at+1} + (1 - q_{t+1})h(e_t)w_{mt+1}.$$

Clearly, the higher the agricultural wage and agricultural employment are, the lower the relative return to education will be, thus reducing the incentive of parents to forgo consumption in order to increase the education of their children. This mechanism will drive our results.

3.2 Solving the model

Education and fertility

The problem faced by an individual born at time t is given by

$$\begin{aligned} \max_{n,e} U_t &= c_t^{1-\gamma} (n_{t+1}Ey_{t+1})^\gamma & (5) \\ \text{s.t. } c_t &= y_t(1 - (\tau^q + \tau^e e_{t+1})n_{t+1}) \\ y_t &= \phi w_{at+1} + (1 - \phi)w_{mt+1}\beta e_t^\theta \\ h(e_{t+1}) &= \beta e_{t+1}^\theta \\ Ey_{t+1} &= q_{t+1}w_{at+1} + (1 - q_{t+1})h(e_{t+1})w_{mt+1} \\ e_t &\geq 0, n_t \geq 0, \text{ and } 1 - (\tau^q + \tau^e e_{t+1})n_{t+1} \geq 0. \end{aligned}$$

The first two constraints give the consumption of the individual and her potential income, where ϕ is an indicator variable taking the value 1 if the individual works in agriculture and 0 if he works in manufacturing. The next constraint gives the human capital of the offspring followed by the expected potential income of an offspring. The last line gives the constraints that fertility, education investments, and consumption be non-negative.

The consumer's problem is solved in the appendix, where we suppose that $\alpha = 0.5$ in order to get explicit analytical solutions. There we show that the f.o.c. yield the following expressions for education and fertility

$$n_t^* (\tau^q + \tau^e e_t^*) = \gamma, \quad (6)$$

$$\frac{1 - \theta}{\theta} e_t^* + \frac{q_t w_{at}}{(1 - q_t) w_{mt}} \frac{(e_t^*)^{1-\theta}}{\beta \theta} = \frac{\tau^q}{\tau^e}. \quad (7)$$

The first equation is standard and gives the quantity-quality trade-off faced by parents, implying that any shock that reduces optimal education investments, e^* , results in an increase in fertility and vice versa. The second equation implicitly defines the optimal education investment as a function of the two wages and population proportions. This equation captures, as in Galor and Weil (2000), the fact that education investment in children depends on the way it impacts the expected wage of the offspring. The main difference with existing work is that investments in education will depend on the relative returns in the two sectors.

Before we fully solve the model, it is interesting to do some comparative statics with respect to q and wages, noting that all variables are constant over time. From the two equations above it is straight-forward to show that $\partial e^*/\partial q < 0$ and $\partial n^*/\partial q > 0$, implying that a higher agricultural employment share reduces education and increases fertility. The intuition for this effect is simply that since education has no value in the agricultural sector, a higher probability that one's children work in agriculture reduces the expected marginal gain of educating an offspring and hence will reduce parents' incentive to invest in their education. An increase in the relative wage in agriculture, i.e. a higher value of the ratio w_a/w_m , would have the same effect as an increase in agricultural employment.

The full solution to the model requires solving for wages and employment. Assuming no mobility costs, income is equalized across sectors and labour market equilibrium is given by the expression $w_{at}p_t = w_{mt}h(e_t)$, which yields the equilibrium values of wages and employment.¹² We are interested in the impact of an increase in the price of the agricultural good, and in the appendix we show that a higher value of p increases the wage rate in agriculture, leading to a flow of labour into that sector, so that agricultural employment is

$$q = \frac{ap^2}{ap^2 + h(e)},$$

where $a \equiv AT/K$. A higher price of agricultural goods and a lower level of education increase employment in agriculture. Note also that if districts differ in the quantity or productivity of their land, they will also differ in their share of employment in agriculture, with a higher A and/or T (i.e. a higher a) resulting in a higher q .

From equation (7) note that the only magnitude that matters for education decisions is the ratio of the expected wage in the two sectors, which we denote ω . It is possible to show that in equilibrium

¹²There is a long-standing debate about the degree of mobility of farmers in France and whether or not their reluctance to move choked industrial expansion. See Sicsic (1992) for a review of the literature and evidence of the comovement of agricultural and manufacturing wages. In any case, all our results would hold if we introduced finite costs of moving into manufacturing.

$$\omega \equiv \frac{qw_a}{(1-q)w_m} = ap^2.$$

The expected relative wage in agriculture is hence increasing in the price of agricultural goods p .

Suppose the economy faces a price of agricultural goods \underline{p} and that the resulting fertility and education decisions are given by \underline{n} and \underline{e} . Consider now the introduction of a permanent tariff on agricultural products at time \bar{t} that increases the price of agricultural goods to $\bar{p} > \underline{p}$. Differentiating the two equilibrium equations, it is straightforward to show that the higher price will result in an education investment \bar{e} lower than \underline{e} and a fertility rate \bar{n} higher than \underline{n} . The former is the result of the decrease in the relative return to education, while the usual quality-quantity trade-off implies that as parents spend less time in children's education, they have more of them. Note also that

$$\frac{d^2e}{dadp} < 0 \quad \text{and} \quad \frac{d^2n}{dadp} > 0,$$

that is, the reduction in education and the increase in fertility are stronger the greater agricultural productivity is. Since a higher a implies that a greater share of population is employed in agriculture before the price shock, districts which have a high initial employment share in agriculture will be those experiencing the sharpest changes in our two variables of interest.

The model hence implies that an increase in the tariff on agricultural goods that raises the agricultural wage leads parents to reduce the educational investment per child and to increase the number of children they bear, the effect being stronger the larger is the share of the population employed in agriculture before the policy shock.

4 Econometric specification

Inspired by the model above, our empirical specification consists of the following two equations:

$$F_{it} = \alpha_0 + \alpha_1 S_i * M_t + \eta_i + \delta_t + \delta_{1i}t + \delta_{2i}t^2 + \epsilon_{it}, \quad (8)$$

$$E_{it} = \beta_0 + \beta_1 S_i * M_t + \mu_i + \gamma_t + \delta_{3i}t + \delta_{4i}t^2 + v_{it}, \quad (9)$$

where F_{it} and E_{it} are respectively fertility and education in department i at time t . We introduce district fixed effects (η_i, μ_i) and year fixed effects (δ_t, γ_t) , while the coefficients δ_{1i} to δ_{4i} capture the impact of district-specific time trends affecting fertility and education. We allow for quadratic time trends when we have annual data but only linear ones whenever we have only

quinquennial census data. M_t is a dummy for whether the Méline tariff is in operation at time t and S_i is the local share of employment in cereal production in the year in which the tariff is introduced. This variable hence acts as a proxy for the capacity for cereal production, and thus the larger S_i is, the stronger we expect the effect of the tariff to be. Note that we cannot identify the non-interacted effect of the variables M_t and S_i , as the impact of the former cannot be distinguished from that of the year fixed-effects and the latter is collinear with the district fixed effects.

Our coefficients of interest are thus α_1 and β_1 , which capture the differential impact of the tariff across districts with different degrees of cereal production. Unified growth theory predicts a trade-off between fertility and education so that the coefficients α_1 and β_1 are of opposite sign. The model above implies that the tariff acts a negative shock to the returns to education, leading to higher fertility and lower education, so that we expect $\alpha_1 > 0$ and $\beta_1 < 0$.

The time structure of the impact of a policy is crucial, as discussed by Wolfers (2006). Although the effect of the tariff on prices is immediate, fertility and education are likely to respond with a lag because wages may adjust slowly and bearing children and educating them take time, but also because both variables are affected by social norms resulting from past behaviour that may slowdown the reaction to policy. We will thus consider two further specifications for each of our dependent variables. For fertility, the first one takes the form

$$F_{it} = \alpha_0 + \alpha_1 M_t * Exp_t + \alpha_2 S_i * M_t * Exp_t + \eta_i + \delta_t + \delta_{1i}t + \delta_{2i}t^2 + \epsilon_{it}, \quad (10)$$

where Exp_t denotes the number of years of exposure to the policy, and we expect the coefficient α_2 to be positive, indicating that households take time to adjust their fertility to the policy.

¹³ An alternative specification, based on Wolfers' analysis of divorce laws, allows for a different impact of the tariff in different years, that is,

$$F_{it} = \alpha_0 + \alpha_1 S_i * M_t + \sum_{k>1} \alpha_k S_i * M_t + \eta_i + \delta_t + \delta_{1i}t + \delta_{2i}t^2 + \epsilon_{it}, \quad (11)$$

where α_1 is the initially effect of the policy and α_k indicates the excess impact that occurs after k years. This specification gives greater flexibility when estimating the impact of the policy, allowing, for example, for the possibility that there is a small impact immediately after the introduction of the tariff while fertility norms adapt to the new regime.

Similarly, we consider two specifications for education which take the form

¹³We introduce $M_t * Exp_t$ not interacted with S_i in this specification since it is not collinear neither with the year fixed effects nor with the time trends which are district specific.

$$E_{it} = \beta_0 + \beta_1 M_t * Exp_t + \beta_2 S_i * M_t * Exp_t + \mu_i + \gamma_t + \delta_{3i}t + \delta_{4i}t^2 + v_{it}, \quad (12)$$

$$E_{it} = \beta_0 + \beta_1 S_i * M_t + \sum_{k>1} \beta_k S_i * M_t + \mu_i + \gamma_t + \delta_{3i}t + \delta_{4i}t^2 + v_{it}. \quad (13)$$

5 The data

Although France has relatively good historical data, the difficulty lies in the unit of observation that we are interested in: the district or *département*, which we term 'department' through the paper. These were the regional administrative units at the time, and are still the main administrative units in France with most of them covering the same areas and having the same names as in the late 19th century, although the number has slightly increased.

We use several sources to compile our data on education and fertility. The first is the *Annuaire Statistique de la France*, from which we have regional data on live births, total population, and the number of students enrolled in primary education. To create measures of fertility, enrollment and attendance, we use the census or *Recensement Général*, which is available for the years 1872, 1876, 1881, 1886, 1891, 1896, 1901, 1906, and 1911, and provides data on various groups of population by age and gender.

Crude birth rates by department are defined as the number of live births per 1,000 inhabitants, while the fertility rate is computed as the ratio of live births to the number of women aged between 15 and 49 in 1,000s. Demographers have raised concerns about a number of observations given in the census as in certain years the various measures available are not consistent with each other. Corrections of these data have been proposed to take into account this concern and we use those to calculate the fertility rate, as proposed by Van de Walle (1974) and Bonneuil (1997).

Our measure of educational investment are enrolment rates in primary education, a measure that includes both public and private schools. Data are available for the overall number of students enrolled in primary education and for those aged 6 to 13, the difference between the two being presumably older students.¹⁴ The data are available separately for all students, for boys and for girls, so we compute both overall and gender-specific enrolment rates. It is conceivable that the tariff had different effects across the genders. For example, if the tariff made agriculture a more desirable occupation and if this was largely a male-dominate activity, girls' education could have been affected less than boys'. Alternatively, if the tariff had a positive

¹⁴See Grew and Harrigan (1991) for an introduction to the data and Luc (1985) for a discussion on the method used by the French education ministry to survey the enrolled.

impact on fertility, this may have kept more girls at home to help with household chores and caring for younger siblings.

To obtain enrolment rates for those in the relevant age group we use the population aged 6 to 13, which is available on census years (1881, 1886, 1891, 1896, 1901, 1906), hence the last observation includes individuals born in 1900, i.e. 8 years after the tariff was introduced. As discussed above the population data by age group is not always reliable, and in a number of cases the enrolment rate we obtain is well over 100%. Since no correction is available for this age group, we simply remove from our sample the observations that are 101% or higher. As an alternative measure we also compute enrolment of those aged between 6 and 13 years as a share of the total department's population.

The number of students enrolled in primary education outside the standard age group (6 to 13 years) can be substantial, amounting to between 35 and 45% of those enrolled in some departments. We therefore construct two additional measures of enrolment: the first is the overall number of students enrolled the total population, the second is those enrolled who are outside the 6-13 age group over the total population.

We start our sample in 1872 and if possible we compile data up to 1913, yielding a 42-year period with half of the observations pre-dating the Méline tariff and half of them occurring after the policy was in place. We exclude from our sample Alsace and parts of Lorraine due to their annexation by Prussia in 1871, as well as Corsica for which there is no data on agricultural employment, thus reducing our sample to 85 departments. Four observations are missing for *Meurthe et Moselle* between 1872 and 1875, as the department was a merge of the two remaining parts of former departments 54 and 57 that were no longer part of France following the 1870 war. Our sample hence contains at most 3566 observations, all of which are available for birth rates. For fertility and enrolment rates the quinquennial availability of censuses reduces our sample to around 500 observations.

Our policy variable is the interaction between a dummy for the Méline tariff and a measure of the importance of cereal production in the department's economy in 1892. Data on the share of employment in cereal production are not available, hence we use as a proxy the product of the share of agricultural employment in total employment in 1892 and the share of the value of cereal production in total agricultural production in 1892, i.e. the last year before the tariff could have an impact. The data concerning these two variables comes from Van de Walle (1974) and Bonneuil (1997). Note that since cereals are generally less labour intensive than other crops, our proxy will be overestimating employment in cereal production. The resulting measurement error

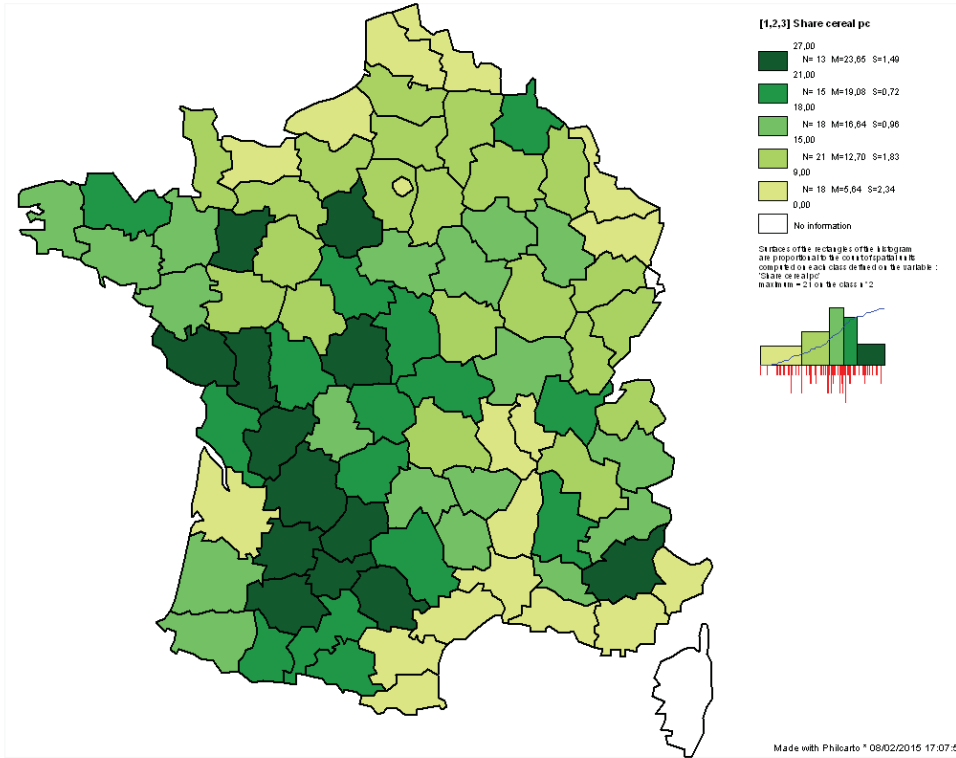


Figure 4: Employment share in local production across French districts in 1892

will tend to bias our coefficients of interest towards zero, implying that our estimates represent a lower bound of the true effect.¹⁵

The dummy variable *Méline* takes the value 0 up to 1892 and the value 1 from 1893 onwards, 1893 being the first year in which we could observe a change in fertility or education. As discussed the time structure of the effect of the policy is of crucial importance, as this variable can have different effects depending on how long the policy has been in operation. We will thus use the variable *Exposure* to measure the number of years that the policy has been in place, and will also allow for differential impacts every three or five years.

Table 2 presents some descriptive statistics. *Méline* is the interaction term between the share of employment in cereal production and the dummy taking a value of one from 1893 onwards and zero for earlier years. As we can see in the table, cereal production was an important activity in France. Its share of employment averages 14.6%, and varied between 26% and 0.07%, with Lot, Tarn et Garonne and Dordogne being the departments with the highest shares and Seine that with the lowest. Note, however, that not all departments with a low employment share in cereals were rich, urban regions. The third lowest share is that of Bouches-du-Rhône, at 3.5%, a relatively poor region but whose climate is not suitable for cereal production. Figure

¹⁵The so-called *attenuation bias*; see Maddala (1977).

4 represents the spatial distribution of the share of employment in cereal production. Both birth rates and fertility rates are high although declining throughout the period, with the average in the sample being 92 children per thousand women.

6 Empirical results

6.1 Fertility

Table 3 reports the results for birth rates. The first column simply includes a 0-1 dummy starting in 1893 which is interacted with the share of employment in cereal production, as well as a department-specific linear time trend. The variable has an insignificant coefficient, indicating that if we impose a common effect over the 20 years following the introduction of the Méline tariff we are unable to identify its effect. As argued by Wolfers (2006), when the underlying process is trended, the way in which the time structure is modelled becomes crucial. The second column hence considers the impact of the number of years during which the policy has been in place (*Exposure*). The coefficient on *Exposure* interacted with the share of cereals is positive and highly significant, indicating that protectionism increased birth rates in those departments with a higher share of cereal employment and that the effect grows over time. Column 3 presents the most flexible specification, based on equation (11), which allows for differential effects every three years. The initial effect, as captured by the coefficient on *Méline*Cereal* is not significantly different from zero, but after three years becomes significant and increases over time, rapidly in the first decade and more slowly afterwards. This seems to imply that households adapted their fertility gradually in response to the change in the relative return to education.

The next three columns estimate those specifications including both a linear and a quadratic department-specific time trend. Coefficients have the same sign and significance, and are somewhat larger. The specification using exposure indicates that the tariff increased the birth rate by 1.33 births in the first year, by 13.3 after 10 years and so on. Similar magnitudes are obtained with the dynamic specification, with no change over the first three years, an increase of about 9.6 births after 10-12 years, and of 19 births after two decades.

Table 4 reports the same specifications using as the dependent variable fertility rates, where, because census data reporting the number of females of child-bearing age is only available every five years, we have only quinquennial observations. The results are consistent with those obtained with birth rates: the interaction between the tariff and cereal production has an insignificant coefficient, but when we allow for a more flexible specification the coefficients are positive and significant. Column 3 reports the regression based on equation (11). Interestingly, we find that

the effect increases over time and is about twice as large at the end of the period as immediately after the shock.

The magnitude of these effects is large. In a department with 26% of the population employed in cereal production, i.e. the highest share that we observe, 10 years after its introduction the tariff had increased the fertility rate by 5.7 children per 1,000 women (column 2). The average increase across all departments is 3.3 children per 1,000 women after 10 years, 6.6 by 1912, figures which are equivalent to 18% and 37% of the standard deviation of fertility. Birth rates increased by 4 children after 20 years, i.e. by 50% of the variation across departments.

As we have discussed, this was a period of declining birth rates and it is interesting to compare the impact of the policy with that of the time trend, since the former offset the decline in birth rates that had been taking place since the late 18th century. Using the formulation in table 2, column 5, we find that the combination of the time trend and the tariff implies that for the average department, i.e. one with a cereal share of 15%, it is only 17 years after the introduction of the tariff that the fertility rate returns to its 1892 level.¹⁶ During the same period, departments with no cereal production at all witnessed a reduction of the birth rate of -3.3 children. In other words, the tariff implied a 17-year delay in the reduction of fertility for the average department.

In order to visualize the differential impact of the tariff, 5 depicts the evolution of the birth rate in 6 selected departments. Two of them, *Seine* and *Bouches-du-Rhône* have the lowest values of our proxy for employment in cereal production, 0.07% and 3.5%. The former encompasses Paris and its surroundings and the latter Marseille and part of Provence, and although they host the two largest cities in France their production structure was very different, with the former having virtually no agricultural employment and the latter having almost 20% of the labour force employed in agriculture, the main crops being wine, fruit and vegetables. As we can see, the introduction of the tariff, indicated by the vertical line, did not coincide with any disruption in the time trend for birth rates. *Landes* and *Saône-et-Loire* have average cereal shares, around 15 percent, and in both cases the data indicate an increase in birth rates after 1892. Lastly, *Lot et Tarn-et-Garonne* have the largest shares, 26 percent; an increase in birth rates is observed in the latter while for the former the rapid decline witnessed over the previous two decades comes to a sudden halt.

¹⁶These calculations use a common time trend estimated on pre-treatment data.

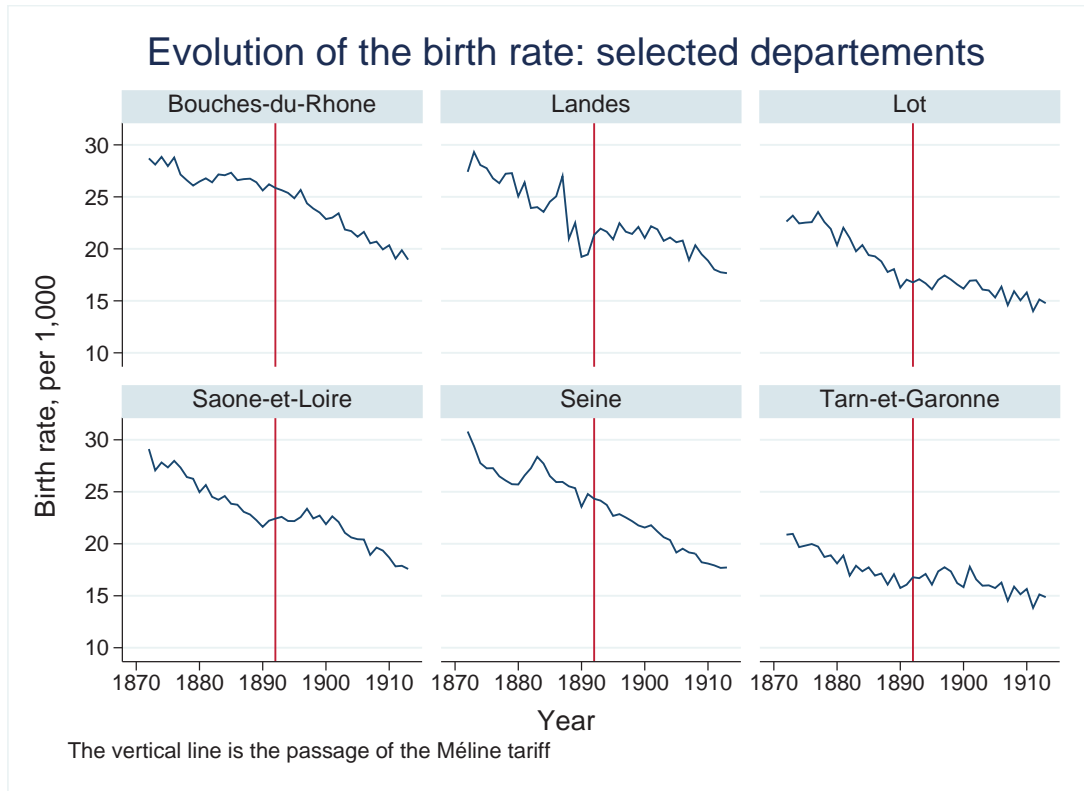


Figure 5: The evolution of the birth rate in 6 selected départements, 1872-1913

6.2 Education

Consider now the effect on education. Table 5 presents the results for enrolment rates, defined as the number of students registered in primary education over the relevant age group (6 to 13 year-old). We report results for all children, for boys only and for girls only since, as we have argued above, the effect could be different across the sexes. The number of observations is constrained by the census years for which we have data on population by age. The last observation is hence for 1911 and includes individuals born between 1898 and 1905, i.e. up to 13 years after the tariff was introduced.

The first three columns report our three specifications for all children: one simply including the Méline tariff interacted with cereal employment, one multiplying this share by the number of years of exposure to the tariff, and another that allows for a different effect in years nine and 14 after the tariff's introduction (the first census after the introduction of the tariff is that of 1896). The coefficient on our variable of interest is negative and significant in all specifications. The next columns present two specifications for boys and girls, respectively. The coefficients are significant and have the expected sign, and imply that there is no statistically significant difference between the two gender groups. There are two possible interpretations for this result.

If cereal production were not gender-biased in France, the tariff would have the same impact on the relative returns of male and female education. Alternatively, if it were mainly males that worked in the cereal sector, two offsetting effects could be in operation: boys' education fell due to a change in its relative return, while girls were kept out of school in order to help in a household where there were now more younger siblings to care for.

Note that the coefficient on Méline in equation (1) is not the average of the three coefficients obtained when we allow for differential effects as the average effects implied by equations (2) and (3), -32.5, are smaller than the coefficient obtained in equation (1) where we impose a constant impact of the tariff over time. The reason for this is that we include in our specifications a department-specific time trend, and in the absence of differential effects of the tariff over time this trend has to capture the dynamics that are actually due to the policy. These differences indicate the importance of allowing for differential impact of a policy over time, as argued by Wolfers (2006).¹⁷

One problem with the data on enrolment rates is that primary education registries indicate that a substantial fraction of students are older than 13. We hence consider separately the number of pupils aged 6 to 13 and those aged over 13. Since we do not have the age range for the latter group, we construct enrolment rates defined as the number of pupils over the total population. The results are reported in table 6. The first two columns consider pupils of all ages and find a negative effect except for the last census year (1911). The 1911 census does not report population by detailed age groups, hence column three runs the same regression dropping that sample year. Columns 3 and 4 report results for the 6 to 13 age group. The tariff reduces enrolment of this age group in high cereal-producing departments, with the effect increasing over time and being significant in all periods. The last two columns of the table examine the enrolment rate of those older than 13, and find no effect of the tariff on the enrolment rate of young adults.

The magnitude of the effect is substantial. Table 5, column (1) implies that for a 15% employment rate in cereal production, the tariff reduces enrolment rates by 6 percentage points, which amounts to almost 75 percent of the standard deviation. These effects are very large when we compare them to the evolution of enrolment rates over time: over the decade prior to the introduction of the tariff, the enrolment rate increased by only 1.4 percentage points in France. When we allow for different effects across time, we find that the strongest impact occurs nine

¹⁷It is straightforward to verify that regressions as those in table 5 but without the department specific time trend yield an average effect that is the same whether we run a regression with only a policy dummy or with differential effects.

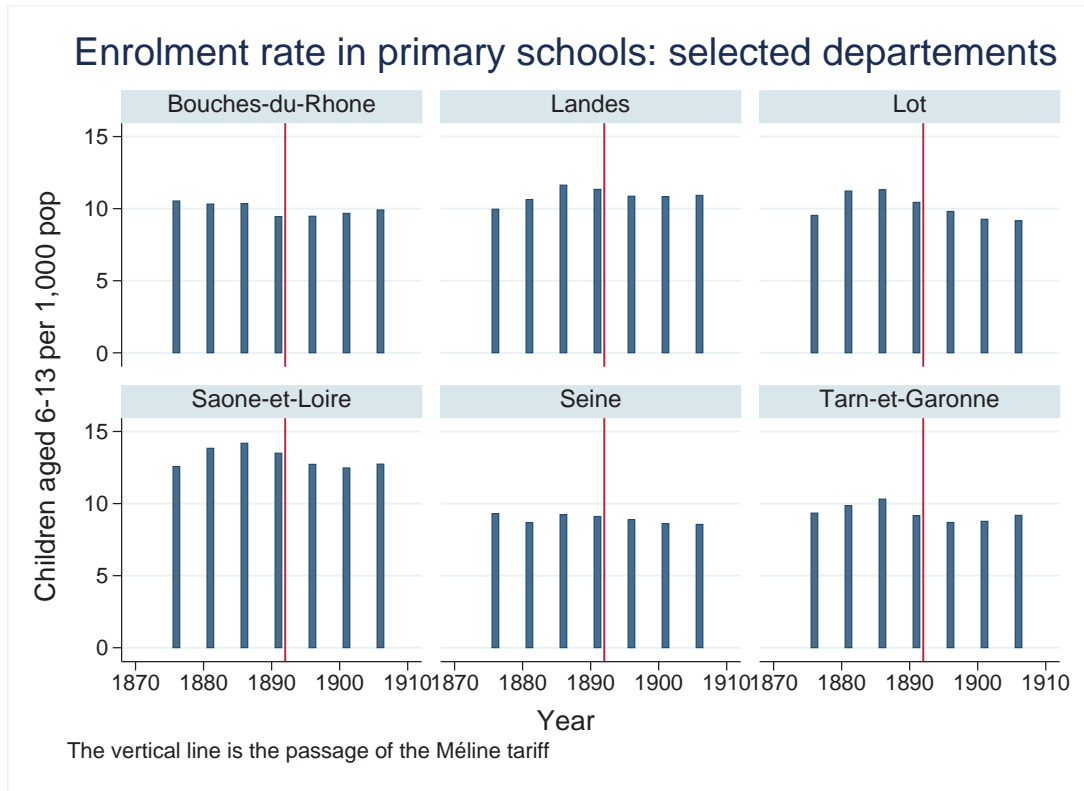


Figure 6: Evolution of the Enrolment Rate in 6 selected départements, France 1876-1906

years after the introduction of the tariff, with the effect falling again by year 14.

Figure 6 depicts six examples of the evolution of enrolment rates: those with the lowest shares of employment in cereal production, *Seine* and *Bouches-du-Rhône*, two with average shares, *Landes* and *Saône-et-Loire*, and those with the highest shares, *Lot* and *Tarn-et-Garonne*. Although enrolment rates appear to have fallen in all départements around 1892, the decline is less marked in the départements including Paris and Marseille, and is particularly strong in *Lot* and *Tarn-et-Garonne*.

6.3 Robustness

To test the robustness of our results we perform two exercises. The first consists of using two alternative agricultural crops. It is possible that our explanatory variable captures some change, for example, technological, that affected another crop. If there is a correlation between employment in the two crops, our explanatory variable could simply be picking the impact of changes related to the other crop. Including the latter would then render the former insignificant. We hence use our *Experience* and *Méline* dummies interacted with the share of employment in wine production and that in fruit and vegetables, both of them major crops in France at the time, with these shares proxied by the product between agricultural employment and the ratio

between the total value of the crop's output to the total value of agricultural output.

The results are reported in table 8. For our three dependent variables, birth rates, fertility rates and enrolment we obtain equivalent results. The coefficient on the shock interacted with the share of cereal employment remains highly significant and of similar magnitude as those previously obtained. While employment in fruit and vegetable production never exhibits a significant coefficient, that on employment in wine production is significant in two specifications, birth rates and fertility rates. A possible explanation is that the increase in agricultural wages brought about by the tariff also rendered employment in wine production more attractive. Regions with geographical conditions favorable to vineyards hence experienced a stronger increase in birth rates.

Our second specification considers alternative time shocks in order to examine whether another shock that took place sooner or latter is being proxied by our explanatory variable. We thus construct the *Méline* dummy and the *Exposure* variable as before, except that we either lag them by 10 years (i.e. the shock occurs in 1882) or forward them by 10 years (shock in 1902). We then interact them with the share of cereals in 1882. Table 7 presents the results for the birth rate, the fertility rate and enrolment rates. These specifications are extremely demanding on the data as they include year fixed-effects, department-specific time trends, and two shocks with a 10-year interval. The first two columns indicate that although the alternative shocks reduce the significant of our explanatory variable, its coefficient remains significant at the 10% level. For fertility and education we have a much smaller sample size. All the shocks have an insignificant coefficient in the fertility regressions, which as we had seen earlier give the least satisfactory results; in contrast, the two regressions for enrolment rates yield highly significant coefficients for our explanatory variable.

7 Conclusions

This paper examines how an economic shock affects education and fertility decisions in order to test the validity of the hypothesis that is a cornerstone of Unified Growth Theory. Our identification strategy relies on a major policy shock that took place in late 19th century France, the 1892 Méline tariff, a large tariff on cereal imports that substantially increased the return to agricultural employment. We develop a two-sector model with endogenous education and birth rates in which, under the assumption that the returns to human capital are higher in manufacturing than in agriculture, a change in the price of agricultural goods implies a reduction in the relative return to education and hence leads to both lower investments in human capital

and higher fertility rates.

In order to test these predictions, we use data on French departments for the period 1872 to 1913 and compute each department's employment in cereal production just before the introduction of the tariff. Our identification strategy is based on the fact that the Méline tariff had a differential effect across departments depending on the share of cereal production in employment. Three outcome measures are used: fertility rates, birth rates, and enrolment in primary education. We find that, in line with the model, fertility and birth rates increased in departments where cereal production was important, while educational attainment fell.

These results contribute to the debate on the origins of modern growth. Critics of Unified Growth Theory claim that at the time of the fertility transition the number of children was not responsive to economic conditions, but rather the result of social norms and the absence of effective birth-control technologies, while education was largely constrained by its supply. A number of previous analyses using historical data have shown that education affected fertility decisions and vice versa, yet no work has so far examined quantity-quality responses to economic incentives. The main contribution of our paper hence lies in identifying how a major aggregate economic shock can impact households' education and fertility decisions.

Our paper also contributes to a vast literature in economic history on the effects of protectionism, which has largely focused on the wave of anti-free-trade policies that swept Europe in the wake of rising imports from the Americas. The Méline tariff stands out as one of the rare instances of a protectionist policy that had a positive effect, notably resulting in higher real wages. Our results imply a more nuanced evaluation of the tariff, making it responsible for the brief increase in fertility that occurred at the end of the 19th century, as well as for the so-called 'lost decade' in education. Further work is needed to fully understand the full consequences of the tariff. In particular, given that fertility and education decisions can be to a large extent perpetuated, protectionism may have created productivity differences across departments that resulted in long term regional disparities. We leave this analysis for future work.

8 Tables

	Observations	mean	standard dev.	min	max
Cereal share in agricultural production	85	.2682	.0775	.0356	.4439
Share of employment in agriculture	85	.5385	.1476	.0151	.7529
Share of employment in cereals	85	.1485	.0612	.0008	.2614
Meline*Cereal	85	.0637	.0837	0	.2614
Exposure to Meline policy*Cereal		.573	.867	0	3.659
Birth rate	3,566	22.46	3.940	13.80	35.43
Fertility rate	763	93.97	17.19	54.89	175.02
Enrolment rate, aged 6–13	595	93.94	8.19	51.99	120.6
Enrolment rate, boys	595	118.99	13.98	64.92	170.52
Enrolment rate, girls	595	118.07	14.67	56.43	164.82

Table 2: Descriptive statistics

	(1)	(2)	(3)	(4)	(5)	(6)
	Meline	Exposure	Dynamic	Meline	Exposure	Dynamic
Meline*Cereal	-0.0487 (1.855)		1.394 (1.716)	-0.101 (1.875)		1.751 (1.232)
Exposure		-0.0508 (0.0359)			0.136 (0.0886)	
Exp*Cereal		0.971*** (0.213)			1.334** (0.545)	
Years4-6*Cereal			3.373*** (1.087)			3.700*** (1.403)
Years7-9*Cereal			4.475** (1.813)			5.214** (2.492)
Years10-12*Cereal			8.354*** (2.334)			9.590** (3.885)
Years13-15*Cereal			11.56*** (2.960)			13.38** (5.590)
Years16-18*Cereal			17.21*** (3.446)			19.69** (7.720)
Years19-21*Cereal			15.85*** (3.881)			19.08** (8.969)
Linear trend *dpt	Yes	Yes	Yes	Yes	Yes	Yes
Quadratic trend *dpt	No	No	No	Yes	Yes	Yes
Adjusted R^2	0.904	0.909	0.910	0.922	0.922	0.923
Observations	3566	3566	3566	3566	3566	3566

Standard errors in parentheses

Notes:

(1) The period of estimation is 1872-1913;

(2) Standard errors are clustered at the departement level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Birth rate

	(1)	(2)	(3)
	Meline	Exposure	Dynamic
Meline*Cereal	17.29 (13.78)		21.07* (11.40)
Exposure		-0.110 (0.172)	
Exp*Cereal		2.196** (1.062)	
Year9*Cereal			2.133 (15.76)
Year14*Cereal			17.31 (27.85)
Year19*Cereal			27.77** (12.41)
Linear trend *dpt	Yes	Yes	Yes
Adjusted R^2	0.718	0.719	0.718
Observations	763	763	763

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Fertility rate - census years only

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	All children	All children	All children	Boys	Boys	Girls	Girls
Meline*Cereal	-40.22*** (11.14)		-32.55*** (11.90)	-41.01*** (11.55)	-34.13*** (12.35)	-45.32*** (11.92)	-37.07*** (12.60)
Exposure		0.0636 (0.205)					
Exp*Cereal		-3.253** (1.338)					
Year9*Cereal			-35.45*** (10.39)		-35.72*** (10.86)		-39.51*** (9.872)
Year14*Cereal			-10.08 (16.72)		-16.78 (16.56)		-13.53 (18.88)
Linear trend *dpt	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.542	0.534	0.557	0.406	0.421	0.609	0.624
Observations	469	469	469	469	469	469	469

Standard errors, in parentheses, are clustered at the departement level.

(1) Enrolment and schooling population are available for years 1881, 1886, 1891, 1896, 1901, 1906, 1911;

(2) The number of pupils aged 6-13 is available every census year except 1911; 1911 figures are absent from column 3.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Enrolment rate enrolled over relevant age group

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	All ages	All ages	All ages w/o 1911	6-13	6-13	Not 6-13	Not 6-13
Meline*Cereal	-4.577*** (1.450)	-5.046*** (1.854)	-5.046*** (1.872)	-4.642*** (1.697)	-4.503** (1.738)	-0.573 (0.906)	-0.543 (1.000)
Year9*Cereal		-2.871** (1.374)	-2.871** (1.387)		-2.163 (1.383)		-0.708 (0.936)
Year14*Cereal		-4.731* (2.661)	-4.731* (2.687)		-3.492 (2.365)		-1.239 (1.136)
Year19*Cereal		-5.707 (3.532)					
Linear trend *dpt	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.590	0.594	0.585	0.547	0.550	0.464	0.464
Observations	680	680	595	595	595	595	595

Standard errors, in parentheses, are clustered at the departement level.

(1) Enrolment and the schooling population are available for years 1881, 1886, 1891, 1896, 1901, 1906, 1911;

(2) The number of pupils aged 6-13 is available every census year except 1911;

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Enrolment rate (enrolled over total population)

	(1)	(2)	(3)	(4)	(5)	(6)
	Birth rate	Birth rate	Fertility	Fertility	Enrolment	Enrolment
Exposure	0.104 (0.0847)	0.0323 (0.106)	0.220 (0.264)	1.517*** (0.417)		
Exposure*Cereal	1.294** (0.527)	1.535** (0.674)	2.127 (1.651)	2.445 (2.561)		
Exposure lagged	0.0983 (0.0905)		-0.595 (0.440)			
Exp*Share lagged	-0.138 (0.552)		0.118 (2.795)			
Exposure forward		-0.222** (0.0912)		-3.444*** (0.640)		
Exp*Share forward		0.399 (0.560)		-0.466 (3.914)		
Meline*Cereal					-35.47*** (13.34)	-38.62*** (11.20)
Meline*Cereal lagged					11.03 (13.91)	
Meline*Cereal forward						12.45 (12.82)
Linear trend *dpt	Yes	Yes	Yes	Yes	Yes	Yes
Quadratic trend *dpt	Yes	Yes	No	No	No	No
Adjusted R^2	0.922	0.922	0.719	0.719	0.542	0.543
Observations	3566	3566	763	763	469	469

Standard errors in parentheses

(1) Enrolment is the enrolment rate of children aged 6-13 over population aged 6-13;

(2) The shock is lagged/brought forward by 10 years;

(3) Residuals are clustered at the departement level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Robustness: Different timing

	(1)	(2)	(3)	(4)	(5)	(6)
	Birth rate	Birth rate	Fertility	Fertility	Enrolment	Enrolment
Exposure	0.0605 (0.0915)	0.111 (0.0937)	-0.355* (0.190)	-0.0687 (0.184)		
Exposure*Cereal	1.589*** (0.523)	1.234** (0.568)	3.022*** (1.019)	2.357** (1.116)		
Exp*Wine	0.741* (0.440)		2.371** (0.978)			
Exp*FruitVeg		0.937 (1.476)		-1.527 (2.743)		
Meline*Cereal					-41.16*** (12.30)	-35.28** (13.64)
Mel*Wine					-2.688 (9.060)	
Mel*FruitVeg						-50.98 (47.77)
Linear trend *dpt	Yes	Yes	Yes	Yes	Yes	Yes
Quadratic trend *dpt	Yes	Yes	No	No	No	No
Adjusted R^2	0.923	0.922	0.722	0.719	0.541	0.544
Observations	3566	3566	763	763	469	469

Standard errors in parentheses

(1) Enrolment is the enrolment rate of children aged 6-13 over population aged 6-13;

(2) Shock is lagged/brought forward by 10 years;

(3) Residuals are clustered at the departement level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Robustness: Different crops

9 Appendix

9.1 Appendix 1

This appendix derives some of the results reported in section 3.

The maximization problem in (5) yields the following first-order conditions with respect to n and e

$$(1 - \gamma)n_{t+1}Ey_{t+1}y_t(\tau^q + \tau^e e_{t+1}) = \gamma c_t [q_{t+1}w_{at+1} + (1 - q_{t+1})h(e_{t+1})w_{mt+1}], \quad (\text{A.1})$$

$$(1 - \gamma)n_{t+1}Ey_{t+1}y_t\tau^e = \gamma c_t(1 - q_{t+1})w_{mt+1}h'(e_{t+1}). \quad (\text{A.2})$$

Dividing one by the other and using the expression for $h(e)$ we get (7) in the text. Rearranging (A.1) and using the expressions for c_t and Ey_{t+1} , we have

$$(\tau^q + \tau^e e_{t+1})n_{t+1} = \gamma. \quad (\text{A.3})$$

Consider now the allocation of labour across sectors. Labour market equilibrium implies $w_{at}p_t = w_{mt}h(e_t)$. Since wages are equal to the marginal product of labour and assuming that $\alpha = 0.5$, we have

$$ap_t^2 L_{mt} = L_{at}h(e_t). \quad (\text{A.7})$$

Substituting for $L_t = L_{mt} + L_{at}$ and defining $q_t \equiv L_{at}/L_t$, we get equation (5).

9.2 Appendix 2

This appendix gives further details on the data.

Territory and population. The French territory was subdivided into 86 *départements*, that were roughly the size of a US county. We dropped the department 'Corsica' because data availability problems.

Demographic variables. The number of births, of female aged 15 to 50 and of the total of the population is available every 5 years, more precisely in 1872, 1876, 1881, 1886, 1891, 1896, 1901, 1906, 1911. The population figures were interpolated yearly using the average of the growth rate of the population between 2 censuses, except in 1912 and 1913 for which we extrapolate the average growth rate of the 1906-1911 period. We use the data available online on the website of the French national statistical institute INSEE (www.insee.fr) and on the website of the *Centre de Recherche Historique* (CRH thereafter) of the EHESS (<http://acrh.revues.org/2890>). Those data were digitized as part of the ICPSR project (<https://www.icpsr.umich.edu/>).

Education.

School enrolment. Throughout the period, primary schooling was compulsory between age 6 and below age 13 but it was pretty common for older or younger children to attend a primary school. A non negligible number of students attend private school and confessional school and we add the number of pupils of those schools to those of public schools. The number of high school students was usually very low in most *département*, which forbid to used the enrollment rate in high school as a measure of secondary education. We take three variables in the periodical published by the Ministry of Education 'Statistiques de l'Enseignement Primaire' (statistic on primary education): the number of children (boys and girls) aged 6 to 13 enrolled in primary school (public or private), the total number of students in any of the primary schools, and the total of children aged 6 to 13 counted in each census. Digitized data are available online at these web addresses <http://acrh.revues.org/3376> for the part digitized by the National statistical office INSEE and <http://acrh.revues.org/3038> for the part digitized by the CRH of the EHESS. Table 9 gives the name of the file and the name of the three variables used to compute enrollment rate. The following corrections were made to correct for typos and errors. In 1881, the relevant variables in file T53.xls that write the number of children enrolled are V176, V177 and V178. They are obviously miscalculated, and we therefore came back to the data published in the Statistical yearbook of the French government that published in its 1884 edition the number of pupils enrolled in 1881 (*Annuaire statistique de la France*, 1884, p. 261). In 1896, there is a typo in the online resource for the number of children aged 6 to 13 enrolled in schools for department #41 that we correct using the *Annuaire statistique de la France* from 22,409 to 32,409. The publication of the survey by the ministry of education was discontinued after 1906. We were able to retrieve the total number of enrolled and the number of children aged 6 to 13 in other sources. We retrieve the number of enrolled students from the section publishing the number on "primary education" in the yearly *Annuaire statistique de la France* (1912, p. 89, reduced to ASF in table 9). We retrieve the number of children aged 6 to 13 by adding the number of children born each year between 1899 to 1905 and alive in 1911. To add 1911 to the database, we add the relevant numbers as they were stored in the census file of 1911 published in dataset number DS244_1 available on the CRH website.

Year	File	Boys & girls			Girls			Boys		
		Aged 6-13 census	Enrolled Aged 6-13	Enrolled all ages	Aged 6-13 census	Enrolled Aged 6-13	Enrolled all ages	Aged 6-13 census	Enrolled Aged 6-13	Enrolled all ages
1876	print	Table 1	Table 31	Table 28	Table 1	Table 30	Table 28	Table 1	Table 29	Table 28
1881	ENSP T53	V207	V211	ASF	V199	V203	ASF	V191	V195	ASF
1886	ENSP T57	V227	V231	V198	V219	V223	V197	V211	V215	V196
1891	ENSP T79	V142	V146	V111	V133	V137	V110	V124	V128	V109
1896	ENSP T83	V44	V48	V9	V35	V39	V8	V26	V30	V7
1901	DS208_1	V110	V114	V75	V101	V105	V74	V92	V95	V73
1906	DS203	V139	V143	V104	V130	V134	V103	V121	V125	V102
1911	DS244_1	census	NA	ASF	census	NA	ASF	census	NA	ASF

V stands for variable, ASF stands for Annuaire statistique de la France, see text for details

Table 9: Sources used to construct enrollment rates

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