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## Highlights

- This paper shows for the first time that the wealth effect of the Black Death on the price level continued in England for generations, up to 1450.
- In absence of consideration of the wealth effect, other influences on the price level do not even appear in the econometric analysis.
- The roles of coinage, population, trade, wages and annual number of days worked for wages all also receive attention and new results follow for adjustment in the labor market.

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## Abstract

The scale of the rise in personal wealth following the Black Death calls the life-cycle hypothesis of consumption into consideration. This paper shows for the first time that the wealth effect of the Black Death on the price level continued in England for generations, up to 1450. Indeed, in absence of consideration of the wealth effect, other influences on the price level do not even appear in the econometric analysis. The separate roles of coinage, population, trade, wages and annual number of days worked for wages all also receive attention and new results follow for adjustment in the labor market.



## Keywords

Black Death, Fourteenth-century England, Price Level, Great Famine.

## JEL

N13, J11, F33, J46.



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# Wealth and Shifting Demand Pressures on the Price Level in England after the Black Death[1]

Anthony Edo[2] and Jacques Melitz[3]

"*Men were dying but coins were not,*" Herlihy (1967, p. 125)

Like most of Europe, England saw both a sharp rise in the ratio of capital to labor and in wealth per capita in the aftermath of the Black Death of 1348-51. As elsewhere, the rise in the capital/labor ratio led to positive wage pressure and the substitution of more capital-intensive methods, notably in agriculture. Large conversions of arable land into pasture for animals also took place if feasible and if not some formerly marginally productive land was abandoned. The rise in wealth per capita led to a reduction of saving, a burst of consumer spending and inflation. Herlihy's oft-quoted and eye-catching quotation applies in this next outcome (Munro 1983, p. 100; 2003, p. 213; 2009, p. 349; Findlay and O'Rourke 2007, p.116). But Herlihy does not go nearly far enough. It is not just the value of money per individual survivor that jumped up in 1348-51, but that of the entire stock of gold and silver consisting of bars, plate, vessels, embroidery, jewelry, other ostentatious goods, etc. In addition, productive land and other forms of productive capital became the property of fewer people. Miskimin's reference to an "inheritance effect" is more appropriate (1964). In this paper, we shall focus on the wealth per capita effect on the price level. In the literature, references to Miskimin's inheritance effect center on the immediate period after the Black Death. This may give the impression that the adjustment to the windfall in personal wealth took place early, at least within decades, especially since deflation followed in 1370-90. Our major argument is that the windfall effect of the rise in wealth per capita in 1349-51 continued to play a role in price level movements as late as a century later. Indeed, according to econometric evidence, other influences on the price level over 1350-1450 hardly show up if the wealth effect is missing from the analysis.

There is a fundamental reason for such a long-lasting wealth effect of the Black Death. Consuming so large an enrichment within the space of a decade or so would be extraordinarily shortsighted. Despite all of the manifest lavish spending at the start and the social atmosphere of impending doom, on any assumption of rational behavior the survivors should have tried to

[1] We wish to thank Stephen Broadberry and Sevket Pamuk for responses and comments.
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maintain a higher standard of living over their lifetimes. The results show they did. In addition, in view of life uncertainty and concern with offspring, the survivors should have transmitted some of their added wealth to future generations and thereby caused the rise in consumption to continue over overlapping generations. They did.

The scale of the wealth effect is important. The English population fell by 46 percent in 1349-51 inclusively. On current evidence, the successive, weaker epidemics in 1352-1400 kept population from rising rather than yielding any further net fall (Hatcher 1977, p. 73, Pamuk 2007, pp. 293, 306, 312, and Broadberry et al 2015, pp. 14-16, 207-8). A 46 percent fall in population would mean approximately an 85 percent rise in personal wealth of survivors at constant wealth (100/54 minus one). However, wealth did not stay constant. There was an immediate and heavy drop in the aggregate value of landed wealth. Some of the tools and equipment of the departed lost their value at once, as these capital assets were complementary with the departed's skills (Miskimin 1975, pp. 82-86). Quite significantly too, some of the wealth became the property of the Catholic Church in Rome as it was willed to be so (Lopez et al. 1970, pp.100-1). Furthermore, even before the wealth per capita had risen to its potential maximum, a rise in the general price level of English output had already taken place in 1348-51 so that the full potential increase could never materialize. Yet making allowances for all of these considerations, the sheer enormity of the gain calls the life-cycle hypothesis into consideration.

Two points demand immediate attention. How could the wealth effect underlie a succession of inflation and deflation? Next, how can we possibly seize this effect for statistical analysis? The answer to the first question lies largely in the fact that England was on a commodity money standard at the time and its value was not under government control. Thus, the rise in the quantity of the precious metals per person resulting from the Black Death would necessarily lead to higher spending of the metals for other goods. So far as these other goods were home-produced, the spending would lower the metals' value in relation to home output, or raise the general price level. So far as the survivors desired foreign goods, however, the fall in the precious metals' value would be checked by the metals' outflow abroad. Had there been a constant division of spending between home and foreign goods, at constant population and constant production at home, that would be the end of the story or largely so. Under familiar reasoning, the rate of outflow of precious metals and the inflation would diminish for a time before the price level attained its new equilibrium level. However, had the higher wealth led to a continuous switch of desired consumption from home to foreign goods, the inflation could have easily turned to deflation before equilibrium was attained, since the prices of home goods would go on steadily dropping relative to prices of foreign goods whereas the price of gold and silver stayed the same at home and abroad. That is exactly what happened.

Following the Black Death, there came at first a substitution of domestic wheat for cheaper grains and added consumption of domestic meat and butter and processed foods. Later there followed imported herring, wine, spices, sugar, oil, wax, luxury cloth, jewelry, ornaments, and furs.[4] As regards coins, the frequent focus of attention, the rise in net imports drove this form of precious metals abroad and, as the foreigners got hold of it, kept down the inflows of foreign coins to the mints at home. Some switch at home toward the desired use of gold and silver for decorative purposes also kept gold and silver from going to the mints (Munro 1983, pp. 105-9; 2003, pp .215-6). Coinage was squeezed from every direction. Munro (2003, p. 134), reports a drop of 88 percent in total coinage from the 1350s to the 1380s, predominantly bunched in 1370-90, the period of deflation. In order to stem the outflow of coins at this time, the authorities introduced sumptuary legislation limiting or prohibiting purchases of luxury goods (Miskimin 1964, pp. 486-90). In sum, the wealth effect of the Black Death can easily explain both the early inflation and the later deflation.

Tracing the time-profile of the extra per capita wealth following the Black Death is a different order of business and no doubt a problem. There is no pertinent data series. Yet it is possible to construct a credible index. There was a sharp rise in per capita wealth at the start presumably followed by a return to a new equilibrium level. We can assign a value of zero to the index at the start in 1348, one at its peak around 1351, and zero again at its end. That gets us started. As for the terminal date, 1375 would be about the earliest tenable choice if we want to allow the possibility that the windfall gain in personal wealth had any major responsibility for the deflation starting 1370. As regards the latest terminal date, 1450 seems reasonable since that year marks the passage from a labor shortage to a labor surplus and therefore the adjustment of the labor market to the Black Death (cf. Munro 2003, Pamuk 2007). The evidence would also clearly indicate a rise in preferences for income-superior goods from abroad very early on, which speeded up the early downward adjustment. As this rise accelerated for some time, a concave shape of the profile of adjustment following around 1351 appears reasonable. We experimented with a wide range of eligible profiles for ending dates 1375, 1400 and 1450. The results unambiguously support the later end date 1450 as opposed to 1375 or 1400. For 1450, the results also show that acceptable profiles over a wide range are just about as likely and significant. The intermediate part of the range is perhaps best. As already indicated, the resulting index proves highly significant in the econometric analysis, and moreover, its presence brings to light other influences on the price level that otherwise remain in the shadows.

[4] Lopez et al (1970), pp. 96-106, 86, Postan (1973b), p. 330, Hatcher (1977), pp. 33-34, Day (1978), pp. 5-12, Miskimin (1983), pp. 79-80, Munro (1983), pp. 105-108, (2003), p. 213, (2009), p. 352, Herlihy (1997), pp. 39-57, Findlay and O'Rourke (2007, pp. 113-16), Pamuk and Shatzmiller (2014), pp. 217-8, Broadberry et al (2015), pp. 77, 215-6.

As for the other influences on the price level, one comes from pressure of the demand for goods on the demand for labor. This pressure is particularly interesting for England because it does not manifest itself especially through money wages, but through the number of days worked annually per wage-earner as divided by total population. There are two fundamental reasons for this. First, landed interests and political powers reined in the rise in money wages through regulations as early as 1349 despite the shortage of labor and the ongoing inflation (Rogers 1846, pp. 297-302, Munro 1983, p. 100, 2009, pp. 345-47, pp. 353-57, Hatcher 1994, pp. 10-19). As a result, real wages failed to rise notably from 1352 to about 1370 but merely zigzagged up and down. Once the deflation of the 1370s started, money wages held up. It was this firmness later on that finally brought real wages on an upward course (Munro 2003, pp.186-90).

Second, the choice facing the agricultural population at the time was not simply between work and leisure, but between work for wages, self-employment and leisure. The availability of work for wages was highly seasonal and a function of the size of the crop. Thus, when demand for labor was high, more days would be worked for wages and less for oneself (by many on rented lands) possibly at the same money wages, and leisure might suffer too. When the demand for labor was low, there would be more self-employment and perhaps more leisure possibly at the same wages (Hatcher 2011). As a result, an upswing of demand for marketed goods would raise days worked per wage-earner rather than, or more so, than wage rates. Humphreys and Weisdorf (2019) recently provided a data series for the number of days worked by individual wage-earners per year. When this series is divided by total population and introduced into the analysis of the price level, it yields a significant positive sign of influence. We interpret this result as indicating that the days worked series is a viable index of the demand for marketed goods in explaining the price level.

Two other influences take part in our explanation of the price level. One is output, which enters with a negative sign, and the other is population, which enters with a positive one. The negative impact of output – or supply of home goods – needs no immediate elucidation but the positive one of population does. This positive population effect must be interpreted in the context of three other variables in the analysis: the wealth per head added by the Black Death, days of work per head, and aggregate output. In the joint presence of these three variables, two of which depend on population directly, the separate impact of population reflects the well-known proposition in history that higher population at given output – the third variable – tends to raise agricultural prices and lower the demand for money. The lower demand for money can be understood as coming from the tendency of agricultural penury to lower money trade relative to commodity credit, barter and production for oneself (Edo and Melitz 2020).

In the context of the literature, we are particularly close to Miskimin (1964, 1975, p.

134-82), who emphasizes the "inheritance effect" of the Black Death and the primary influence of the adverse balance of payments in explaining the deflation of 1370 to 1390. We arguably distinguish ourselves from him in our heavier emphasis on the Black Death as a factor in the increase in the demand for imports. But our extension of the wealth effect of the Black Death beyond the 15th century clearly sets us on a different path.[5] In this connection, Findlay and Lundahl (2002) treated the adjustment period as even longer than we do, but on totally different grounds. They adopt a Malthusian approach and consider equilibrium restored only when population returns to its pre-Plague level, or more than three centuries later in the English case.[6] In common with Miskimin, we are particularly distant from Postan, the leader of the "populationist" school, who explicitly denies the importance of the impact of the wealth effect of the Black Death, particularly its impact on the real money stock (1973a, ch. 1 (revised version of a 1950 conference paper), pp. 7-16, 1973b, ch. 4 (original published in 1952), pp. 181-5). Yet our deviation from him is not thoroughgoing since we allow a large role for population, as the preceding paragraph says.

Munro is a contributor of note. While associating himself with Miskimin against Postan, he goes much further than him and we do in embracing a monetarist position. Reminiscently of Milton Friedman, Munro says: "The post-plague European inflation was again clearly a monetary phenomenon" (Munro 2003, p. 212). His reasoning, very familiar, is that issues of agricultural prices pertain to relative goods prices, while the price level must be a monetary issue, depending on the supply and demand for money. "To be sure," he says, "[population growth] can explain why grain prices rose more ... But the explanation for a general rise in prices, i.e., a rise in most prices has to be sought in monetary explanations" (Munro 2009, pp. 335-7). In the same vein, Munro (2003, p. 134)) puts particular weight on the causal influence of the massive drop in total coinage from 1370 to 1390 in explaining the later 14th-century deflation. However, his view is difficult to reconcile with the fact that money was endogenous and moved with the winds of trade. Since Munro reflects a very large body of opinion, the hypothesis that coinage has little or no value as an explanatory variable will receive special attention below.

A potential money-supply-side influence that we will take seriously is the output of European mining. This potential influence is well-recognized in the literature. "For many historians," Munro (1983) reports, "the earliest and principal cause of a general European

[5] To quote Miskimin (1989, p. 697): "While the inheritance effects of Plague might temporarily augment the wealth of the survivors, a persistent drain on the money supply would inevitably end any fleeting prosperity that might have resulted from the concentration of assets through death." Similarly, see Miskimin (1964, p. 490).

[6] Findlay and Lundahl (2002) also use a tailor-made model where the mining industry produces silver at will under increasing marginal cost and for this reason the Black Death yields an initial upward spike in the price level followed at some point by a reversal as money flies out of the country (Europe) in the chase of luxury goods to the East *without any role for the wealth effect*.

monetary contraction per se was a severe slump in European silver mining from the thirteenth or early fourteenth centuries, variously in Saxony, Bohemia, the Tyrol, Alsace, England and Sweden" (pp. 98-99). Any European mining outside of England (a negligible contributor to the mining at the time (Allen 2011, pp. 120-21)) would have exerted an exogenous influence on the country's inflows of precious metals via foreign trade, and even apart from such inflows, via European commodity price integration. It turns out, though, that this monetary factor does not show up as significant, any more so than coinage.

The next section will provide a theoretical framework. Section II will discuss in more detail the construction of the profiles of the wealth per person attributable to the Black Death that serve in the analysis. The ensuing one, III, will discuss the series for coinage and the production of precious metals entering in the robustness tests. Section IV will present and discuss the graphical evidence of the behavior of the major variables in the study period except for the afore-discussed per capita wealth attributable to the Black Death. The study period is 1300-1450. Beginning thus far back before the Black Death improves the ability to capture the importance of the response to this catastrophic event. However, the early 1300-47 stretch was a tormented one as well, with pronounced movement in the price level and output up and down. A central factor was the Great Famine of 1315-22, the most important in England of all the Middle Ages. Nonetheless, we will keep our focus as much as possible on the Black Death in the subsequent pages. Section V will provide the main econometric results and section VI the robustness tests. The closing discussion section will delve more deeply into the implications of the analysis for England and argue for the wide application to other parts of the world.

## I. The theoretical framework

Consider a situation in a home country with three goods and one capital asset. All three goods are composites of individual ones. The first two composites are home-produced and the defining difference between them is that one is marketed, $O_M$, and the other is not, $O_N$. The $O_M$ composite is income-superior to the $O_N$ one. It is also higher priced. Many components of these aggregates can move from one aggregate to the other and the aggregate $O_N$ can be priced. Significantly, total home output, O, is given. But the composition of output between $O_M$ and $O_N$ is not but depends on the market demand for $O_M$, $O_M^d$. The supply to meet this market demand at home is infinitely elastic. This obviously accommodates the important seasonal flow between $O_M$ and $O_N$ in agriculture, as well as the numerous shifts of output, both ways, between rural and urban areas. The third good is a composite of imports, $O_F$, which is income-superior to $O_M$. The imports are luxury goods. The capital asset is a fourth aggregate with a single world price, which is set abroad and enters in all market transactions. Prices of $O_N$, $O_M$, and $O_F$ are

all stated in terms of a particular weight of a homogeneous element of the capital asset. The price level of home output P is:

$$P = \alpha P_M + (1 - \alpha) P_N \qquad P_M > P_N \quad 0 < \alpha < 1 \tag{1}$$

$P_M$ / $P_N$ is a constant, that is, the two prices move together. Therefore, all adjustments to the demand for $O_M$ relative to $O_N$ take place through changes in α or shifts from work for sale to work at home and inversely. $P_F$ is determined abroad. For this reason, any rise of $P_M/P_F$ must mean a rise in P and fall in the value of wealth at home, and inversely.

Since the effect of the rise in per capita wealth in 1348-51 is our major concern, we will proceed in first differences from the start for all the variables. The next equation is for inflation π:

$$\pi = f\,(g\,(\alpha), g\,(O), g\,(Pop), g\,(W)) \tag{2}$$

$$f'\,(g\,(\alpha)) > 0; \quad f'\,(g\,(O)) < 0; \quad f'\,(g\,(Pop)) > 0; \; f'\,(g\,(W)) > 0;$$

g (α) is the rate of growth of α, g (O) is that of output, g (Pop) that of population, and g (W) will be defined shortly. The positive sign of g (α) depends on $P_M > P_N$ in Equation (1). The negative one of g (O) reflects the usual negative effect of supply on price and its accompanying positive effect on the demand for real money balances. The positive one of g (Pop) reflects the aforementioned populationist argument: more people at given output leads to a drop in material welfare and thus a willingness to sacrifice liquid capital for goods. For the most part, this reduction would mean less money trade in favor of non-money trade and self-production. Nonetheless we need not identify the conglomerate capital asset with money. Different elements of the asset may have different degrees of liquidity as long as the total desired liquidity is not a separate independent factor.

g (α) is endogenous, unlike g(O) and g(Pop). The two equations that govern it are:

$$g\,(\alpha) = h\,(g\,(O_M^d/Pop)), \qquad \text{where } h'(g\,(O_M^d/Pop)) > 0 \tag{3}$$

$$g\,(Days/Pop) = d\,(g(O_M^d/Pop)), \qquad \text{where } d'\,(g\,(O_M^d/Pop)) > 0 \tag{4}$$

The positive sign of $h'(g(O_M^d/Pop)$ follows from the fact that the supply of $O_M$ meets the demand for it, $O_M^d$, at any population level. Equation (4) is a short step from (3) since production requires labor, and therefore raises average days worked for wages relative to the total population, Days/Pop. Evidently a rise in α implies a shift from work at home to work for wages. g(Days/Pop) will then serve as a proxy for g (α).

W represents the time-profile of the change in per capita wealth attributable to the Black Death. It is an index that goes from zero in 1348 to one in 1351 and then is back at zero once the new equilibrium in the wealth-saving relation is attained. During its rise W is a cumulative value, which we will label $W_o$. Consequently, $W_o$ at its height stands for the total size of the initial windfall of the Black Death on per capita wealth. During the adjustment period following 1351, transfers of wealth between residents do not affect W. Only movements of $W_o$ abroad to pay for imports do. At the end of the adjustment, when W is back at zero, all of the initial windfall remaining in England is simply desired. Equilibrium in the wealth-saving relation is restored.

The following equation defines W where time subscripts are essential:

$$W_t = W_{o,s} + \beta_{s*} \tag{5}$$

s=t for time 0 to t* where t* is the time when $W_o$ attains 1, s* = t for time t* to t** where t** is the time when W is back to zero. Though $W_t$ in Equation (5) contains two separate terms, it always depends only on one of them. From time 0 to t*, $W_t$ equals $W_{o,s}$ and from time t* to t** it equals $\beta_{s*}$. β is the *fraction of time* left after t* before equilibrium takes place. It is 1 at the start and 0 at the end when t = t**. β is entirely a function of the initial windfall. It results from the windfall's provocation of rising tastes for foreign relative to home goods and the consequent outflow of $W_o$ abroad. The next equation concerns the time profile of β:

$$\beta = j\,(s^*) \tag{6}$$

$$j'\,(s^*) < 0;\;\; j''\,(s^*) < 0 \text{ up to } s^* = n \text{ where } n \leq t^{**};\;\; j''\,(t) > 0 \text{ from n to } t^{**}$$

β falls right from the start at time t*, its fall accelerates until time *n* as the growth in tastes for luxuries accelerates, and subsequently its fall decelerates until equilibrium comes at t**. In the tests, we shall experiment with other but kindred specifications of j (s*) in Equation (6). Notably, β does not reflect the size of the outflow. In fact, the proportion of $W_o$ at t* still at home when W is back to 0 at t** could be high, since it depends on the people's wish to retain some portion of the initial windfall as desired "hoarding" in equilibrium. Equation (6) is silent on the size of this portion. Thereby its use lightens the demands made upon our knowledge of the facts. The equation for the growth rate of W readily follows:

$$g(W_t) = \begin{cases} g(W_{o,s}) & if\ n \leq t^* \\ \frac{j\prime(s^*)}{\beta_{s*}} & if\ n > t^* \end{cases} \tag{7}$$

$g'(W_{o,s}) = \frac{dg(W_{o,s})}{ds} > 0$ ; $g''(W_{o,s}) < 0$ ; $\frac{j\prime(s^*)}{\beta_{s*}} < 0$; $\frac{j\prime\prime(s^*)}{\beta_{s*}} < 0$ until $n$ and $> 0$ from $n$ to t** where j'(s*)/$\beta_{s*}$ is the growth rate of $\beta_{s*}$. $W_o$ grows at a diminishing rate from 0 to t*.

Note that the money wage is nowhere in the system. As mentioned at the start, the effect of the Black Death on the capital/labor ratio brought about a sharp rise in wages. Our assumption is that this was a relative price change and that any associated rise in the price level came strictly from the drop in output, which we take as exogenously given. The money wage could then still be positively associated with P because a rise in the demand for marketed goods $O_M^d$ raises the demand for labor for wages and thereby might raise money wages along with $P_M$ and P. However, we have excluded this labor market channel of influence of wages by assigning it exclusively to shifts of labor between market and non-market activity. We shall check later on the merits of this assumption.

The problem is to estimate Equation (2). To proceed, we propose the following reduced form of Equation (2):

$$\pi = f\,(g\,(W),\ g\,(Days/Pop),\ g\,(O),\ g\,(Pop)) \qquad (8)$$

where Days/Pop stands for α in Equation (2). Next, the estimating equation is:

$$\pi = a_o + a_1\, g\,(W) + a_2\, g\,(Days/Pop) + a_3\, g\,(O) + a_4\, g\,(Pop) + a_5\, X + \varepsilon \qquad (9)$$

where $a_1 > 0$, $a_2 > 0$, $a_3 < 0$, $a_4 > 0$ , $a_5 < 0$ and ε is a disturbance term with the usual statistical properties: zero average, constant variance, and no autocorrelation in time. The variable X remedies a shortcoming in the hypothesis of a *uniform* positive sign of $a_1$. In the immediate years following the peak of W, W and π should have opposite signs for a spell during which the impact of the rising demand for domestic output on the price level still overrides the rising demand for foreign goods. For this time, presumably brief, the price level keeps rising but at a diminishing rate. X is a dummy variable for those years and its expected sign is negative.

Before proceeding, let us pause to consider how money relates to the system. W comprises the whole range of different individual capital assets in England at the time. The assumption that W has a single price is a drastic simplification grounded on the assumption that price movements of any element of W relative to the rest play no independent role in the system and can be neglected. For empirical reasons, money is best understood as a modest fraction of W. Admittedly, the entire transfer of W abroad takes place through movement of this component. Yet that feature does nothing to explain the movement itself. Introducing the money stock as a separate influence would thus require separate defense. Collective control

over the aggregate stock of money would be ineligible as such a defense, though as recognized earlier, fresh mining could be. In a related fashion, we shall also consider below the possible effect of the One Hundred Years War with France, which would be partly monetary.

## II. The time-profile of the windfall effect of the Black Death

The time-profile of W in our experiments follows. As noted, we begin with zero in 1348 and set the value of one in 1351. The maximal value of $W_o$ or W could really come a year or so later because of delays in the settlement of property rights. As already indicated too, we select 1375, 1400 and 1450 as three possible terminal dates t** for full adjustment. We shall entertain four different time-profiles of W for each of these three dates. Figure 1 displays the four for 1450. The first profile, A, is linear. It corresponds to a situation where the increase in tastes for luxury goods proceeds steadily without accelerating over time. In terms of the notation in Equation (6), j' (s*) < 0 but j'' (s*) = 0. The polar limiting case, Profile C, is one where the increase in the tastes for luxury goods never ceases to accelerate. Thus, the profile remains concave throughout. The two intermediate cases, Profiles $B_1$ and $B_2$, are the ones that correspond exactly to Equation (6). They display cases where the increase in tastes for luxuries ceases to accelerate at some point *n* in the adjustment process but continuously weakens thereon. In case of $B_1$, the point *n* comes earlier than in the case of $B_2$. In principle, there obviously exists an infinity of possible profiles of the sort $B_1$, $B_2$ and C for any terminal date. But the three plus A suffice to form a clear picture, as we will see.

[Figure 1 here]

It may help before proceeding to spell out the significance of the ex post value of the price level at the time of the complete adjustment of individual wealth to the Black Death. If we reason at constant population, at the terminal date 1450 the population lost about 14 percent of its inherited wealth in precious metals from its forebears to inflation. Earlier we failed to advance any figure for the percentage increase in personal wealth over 1348-51, only the judgment that the figure was high and below 85 percent. Let us arbitrarily pick 46 percent for illustration or the death rate attributable to the Black Death. In this case, a size population equal to that of the initial survivors in 1450 would have lost 30 percent of the initial gain (14/46) to inflation. In fact, the population fell by about 25 percent from 1351 to 1450, so that the per capita fall was smaller, only 23 percent. The other 77 percent either remained at home (as desired "hoarding"), or disappeared through physical depreciation without replacement, or was

lost abroad in the purchase of foreign goods.

## III. The time profiles of the main series

We draw all of our data for the price level, population, wages and output from the massive work of Broadberry et al (2015), which we shall treat as authoritative. Only the days of work per wage-earner per year comes elsewhere, from Humphreys and Weisdorf (2019). Figure 2a presents the smoothed price level series for 1300-1450, and Figure 2b is a blow-up of the 1335-1400 segment of this graph. The blow-up displays clearly the sharp up-and-down movement in 1348-1400 of which we wrote. There is also an earlier deflation in the 1300-1348 period, coming in 1320-47, that is even sharper than the one in 1370-90. During this time, population growth stretched the output of agriculture to its limits (see Lopez et al. 1970, pp. 96-97, Miskimin 1975, pp. 23-25, Broadberry et al 2015, pp. 260, 370-2, 377-8, 424; and Findlay and Lundahl 2006, pp. 190-1), and while this should have led to an excess demand for goods relative to money and therefore a rising price level, the opposite took place. Some historians blame tight money, but we shall attribute the principal responsibility to Days/Pop.

[Figures 2a and 2b here]

Figure 3 presents the population series in 1300-1450. In this case, we show the unsmoothed data rather than the smoothed one in order to bring out better the extraordinary concentration of the reduction in population in 1349-51. The data points for population are unusually few because more detailed Wrigley-Schofield (1989) population figures, based on parish records, only start in 1541. Of note, the English population continues falling in 1351-1450. As presaged earlier, this happens not because of repeated epidemics and war but reduced fertility rates.

[Figure 3 here]

Figures 4a and 4b show nominal wages and real wages respectively after smoothing in 1300-1450. From Figure 4a we see the aforementioned long run stability of nominal wages before and after the brief upward spike with the Black Death. This stability displays the wage stickiness to which we alluded. The sharp rise in real wages in 1370-1390 in Figure 4b resulting from deflation is also easy to see. Figures 5a and 5b show smoothed output and output per capita. The opposite movement of the two during 1348-51 is striking: the aggregate collapses while the per capita value surges upward. We also can see in the figure the joint fall of both

series starting with the economic recovery of 1370 and lasting to the end of the 14th century.

[Figures 4a, 4b, 5a, and 5b here]

Figure 6 concerns Days/Pop, whose importance we have stressed. The figure shows both the yearly days of work per wage-earner after smoothing and this yearly number divided by population (in millions). The vertical axis on the left refers to days worked per wage-earner divided by population and the one on the right to days worked per wage-earner as such. Since the two axes are in different units, the point of intersection of the two curves is entirely arbitrary. The period of the Black Death brings into sharp relief the importance of the distinction. As can be seen, in this period the number of days of work per wage-earner continued on a previous downward course, whereas with the precipitous drop in population, the number of days worked divided by population moved sharply upward. It is plainly the latter upward movement that correctly reflects the pressure coming from the demand for marketed goods in the labor market. This last market was very tight at this time; there was an excess demand for labor; property owners could not find adequate help while wage-earners were able to get both higher wages and more leisure time.

[Figure 6 here]

Figures 7a and 7b relate to coinage. To test its proposed insignificance, we shall use two measures of coinage, one from Palma (2017) (his “direct” measure) and another from Munro (2003). The key originality of Palma’s measure is his identification of a set of reliable points (his Table 1) that can serve as pillars for the rest. Following, he interpolates the annual data based on the best available evidence. Seven of his safe points affect our series for 1300-1450, three of them for 1351-1450. The Munro (2003) series for coinage in 1300-1450 (Table 4) differs essentially in construction by treating no values as more reliable than others (pp. 134-5, 142-5). The Munro series are quinquennial and needed to be annualized.

[Figures 7a and 7b here]

The one statistical series in our work that we do not display is for the mining of precious metals in the rest of Europe, a possible money-supply-side factor. In this case, we rely on figures from Spufford (1988, chapters 6 and 15) and Blanchard (2005, pp. 932-1035) with some use of Day (1978).[7] All the smoothing of the series in these figures is over five years.

[7] A much-extended form of this series, which we constructed ourselves based on further sources, serves us in Edo and Melitz (2020) to examine the “Great inflation” following the discovery of the New World.

## IV. The results

We begin with the estimates of Equation (9) for terminal W in 1450. Later we shall present those results for the earlier terminal dates of 1375 and 1400. Those will be distinctly worse. We shall also start with our profile $B_2$ for terminal date 1450. Table 1 provides the estimates with one-year lags for days of work. We experimented with lags for population too, as we expected to find them. But no lagged effects emerged, perhaps because of the unusually low number of raw observations of population in our study period, which must hinder all efforts to infer a lag structure. Unlike the figures, where all variables except population and W are smoothed over five years, output is not smoothed in the tests themselves (though the rest of the smoothed variables in the figures are).

The first column in the Table introduces g (W) – simply growth of "wealth" from here on – and growth of days of work per wage-earner divided by population. Both emerge as highly significant at the 1 percent level with the right positive signs. The next column introduces the lagged dependent variable, inflation, in order to guard more strongly against autocorrelation in the residuals and downward bias in the standard errors. Wealth is essentially unaffected but days of work suffers. In the third column, we introduce output growth without lagged inflation. Output is not smoothed (as it was in Figures 5a and 5b), though it performs much better with smoothing because the improvement comes partly or largely from reciprocal effects of prices on output (based on causality tests). Both wealth and days of work are as significant as before in the first column, while the output variable has the right negative sign and is significant only slightly below the 5 percent level. In addition output's presence clearly matters as it yields a substantial rise in the coefficient of Days/Pop, which makes sense, for in output's presence the coefficient of Days/Pop no longer reflects the negative impact of output on the price level, coming through output's positive association with Days/Pop. The fourth column adds lagged inflation to the preceding estimate. Once more, days of work becomes insignificant. Column 5 adds population growth without lagged inflation. The improvement is considerable: days worked becomes highly significant once again with a higher coefficient than before and the *t*-value of wealth rises notably while population is highly significant too. The next column, 6, reintroduces lagged inflation. This time the improvement goes even further. Not only does the significance of wealth remain unaffected, but the presence of lagged inflation no longer damages the significance of days of work despite the more stringent test of absence of autocorrelation in the residuals, as it did in the previous column 4. To all evidence, control for population is highly important. It even helps to render the significance of days of work clearer, as is plausible. The final column 7 introduces the correction for the period following 1351 when W falls yet the price level is expected to continue rising but at a diminishing rate. Based on

preliminary tests, this stretch lasts approximately 4 years, 1352 through 1355. The coefficient of X for these years is indeed negative and highly significant, and in its presence, the significance of W rises, as also makes sense. Furthermore, X's presence improves the performance of days of work and population as well as that of W.

In sum, the performances of wealth, days of work, and population in Table 1 are excellent. That of output is arguable but we prefer to retain it.

Table 2 next repeats the results of columns 1 and 7 of Table 1 for all four alternative profiles of W. The order of the profiles goes from A to $B_1$ to $B_2$ to C. The main outcome is clear upon examination: there is little of fundamental importance hinging on the choice of profile. The results fundamentally agree. Wealth, days worked and population, all three, are important for all four profiles. In the linear and uniformly concave examples, A and C, which are meant to reflect the relevant extremes, the results are even difficult to tell apart. Similarly, in the two intermediate cases, $B_1$ and $B_2$, the results are difficult to distinguish. Overall, the profiles $B_1$ and $B_2$ yield a better fit than A and C by a minor margin. But we also prefer them on conceptual grounds.

Next follow the tests with the earlier ending dates 1375 and 1400 for wealth. Now the results differ starkly. Table 3 provides these results for Table 1, column 7, which will be our baseline equation. Profile C works badly. As for the other three profiles, wealth and days of work continue to perform well but not nearly as well as before. Both their coefficients and their *t*-values drop heavily; indeed for profile A and ending year 1400, wealth falls below significance at the 10 percent level while days of work remains so only at this level. In addition, population becomes insignificant except for Profiles A and $B_2$ with ending date 1375. Even then its significance is notably lower than before. The 1352-55 dummy is uniformly insignificant. Thus, admission of the lengthy operation of the wealth effect of the Black Death on the price level, well beyond 1400, is needed for the joint significance of all the variables in the baseline model to emerge unambiguously. On the other hand, the exact profile of the effect between A, $B_1$, $B_2$ and C is secondary.

## V. The robustness tests

All the robustness tests pertain to the baseline with the wealth effect ending in 1450. The first and foremost robustness test pertains to coinage. Low coinage is often invoked to explain the sharp deflations of 1317-39 and 1370-90 in our study period. Indeed low coinage was a feature of both periods. As indicated, to test we shall consider Palma and Munro's coinage series as the two alternatives. We will also provide three separate estimation results for the two in growth terms. The first duo of results, in columns 1 and 2 of Table 4, concerns

the case where coinage is the only variable. In these columns, both series are positive but only Palma's is significant, even highly so. This would indicate some apparent support for the importance of coinage. Indeed, if the estimates were in levels instead (rather than first differences), which people have had in mind, they would be better. The second duo of results, columns 3 and 4, concerns the baseline with coinage. Now Palma's measure remains significant somewhat below the 10 percent level and Munro's stays as insignificant as before. In either case, coinage's presence does not affect the baseline in the least. The third and last set of results, columns 5 and 6, repeats the previous test while dropping the wealth variable. The point is to meet the possible objection to columns 3 and 4 that the presence of wealth hides the true significance of coinage since wealth reflects coinage post-1351 or so. If fact, this last trial brings out more starkly than ever the insignificance of coinage and the high significance of wealth instead. Not only are both coinage measures insignificant at the 10 percent level in these last two columns, but also no other variable in the estimates remains significant except for lagged inflation. Thus, removing the wealth effect leaves us virtually blind in the econometric analysis.

As mentioned before, another familiar idea from which we depart is that the demand for labor significantly affects money wages. In our model, this demand principally affects days worked instead. The next tests in Table 5 focus on the issue. In the first column, we enter the growth of the money wage rate (smoothed) into the baseline instead of growth of days worked. The wage variable is significant at the 5 percent level and population remains so too, less strikingly than before. In the second column, we restore days worked while also keeping the money wage. Now the coefficient of the wage variable goes down almost to zero, days worked is significant at the 1 percent level, and wealth is as important as in wage's absence. Treating days worked alone as reflecting the demand for labor thus looks very safe.

There are some other omitted variables that deserve consideration as exogenous influences on the price level. Table 6 focuses on these, and starts for convenience by repeating the baseline equation. The first new influence, in the second column, is mining of precious metals in the rest of Europe. Since it is highly implausible that this influence would affect the English price level within a single year, we experimented with lags of 5 to 10 years. The results all come to the same and we show the outcome for lags of 10 years in the second column. Mining is insignificant.

The next missing influence, column 3, relates to the victorious Hundred Years war with France in 1337-1453, covering our entire post-Plague period. The war was financed variously: through taxes, debt, transfers of royal property, the decision to monetize gold by coining it in 1344, booty from France (ransom and plunder), and also but less significantly, debasement and recoinages (Postan 1973a, ch. 4, pp. 53-59, ch. 5). The war might have raised prices

through the royal spending financed in a number of these ways, especially debt and monetization of gold. Yet this cannot be sure since much of the spending took place on French soil where the fighting happened and to pay for foreign allies. To test, we use Broadberry et al (2015)'s series for government real spending on services (smoothed) which was predominantly for defense and war. This variable, well correlated with coinage, is also insignificant. In this case, perhaps negative forces compensated for the positive ones.

Following, we consider the influence of the Great Famine of 1315-22, sometimes described as that of 1315-17. In this instance, we introduce a dummy variable for 1315-17 and for 1315-22 in sequence. As columns 4 and 5 show, both dummy variables prove insignificant. However, this treatment of the Great Famine is admittedly minimal and a more satisfactory treatment remains for later research.

The next three columns introduce dummy variables for 1349, 1349-51 and 1349-1450 successively to test for the possibility that the Black Death produced a break in the various influences on the price level that wealth alone fails to capture. The dummy variable for 1349 is moderately significant with a negative sign (signifying that inflation that year was moderately significantly below the average over 1300-1450). In consequence, the positive value of the coefficient of wealth nearly doubles. The next dummy variable, for 1349-51, is totally insignificant and, in its case, the coefficient of wealth returns to its level and order of *t*-values in the first five columns. In this last case, population also ceases to be significant, clearly because of multicollinearity with the 1349-51 dummy. The third and last dummy variable covers the entire study period starting with the Black Death, 1348-1450. This dummy also proves totally insignificant and does not alter the rest of the equation. There is therefore no trace of a break in the structure of the economy caused by the Black Death apart from the wealth effect. The ninth and last column probes further into this last and possibly unexpected result. There we simply lop off the early part of the sample and center strictly on the post-Black Death period and onward 1348-1450 at the cost of a third of the observations. The column shows equivalent results to those before. Notwithstanding, we consider the full 1300-1450 sample period as far the more instructive one.

Finally, we check on our assumption underlying all the estimates that the four explanatory variables in the baseline equation are exogenous. Granger causality tests serve and Table 7 contains the results. The table shows the Wald statistics for each of the four independent variables as a function of the dependent one, inflation, first with one lag, next with a second and third lag too. The table also shows separate results without and with controls for the other three independent variables. The parentheses contain the probabilities. In all cases the causality of our independent variables can be accepted at the 10 percent level. In the one-lag case there is little question. In the three-lag case, the results may be considered only

passable for wealth, and also for population in the case where the other independent variables are present. We had indeed expected better results for wealth, since we had bent our efforts to construct the index with no consideration of inflation. Nonetheless, it is important to keep in mind that any causal impact of inflation on our wealth variable would be negative. Therefore, any reciprocal-influence bias would be downward, meaning even higher coefficients for wealth.

## VI. Discussion

Our starting hypothesis in this study was that the wealth effect of the Black Death has been short-changed. So large a population contraction in so brief a period must have affected survivors' saving behavior for longer than is usually contemplated. The life-cycle hypothesis, so successful in studies of the past century, would say so. The hypothesis is also as plausible for the 14th century as it is today. It depends on elementary self-serving behavior and not highly sophisticated financial markets. Possible investment in durable non-human capital is the essential economic requirement. In order to test the hypothesis, we needed to construct an index of the effect of the Black Death on personal wealth. The study also necessitated a number of departures from usual economic analysis. One of them is a strict adherence to endogenous money (not mere acknowledgment of it) under a commodity money standard. Another is admission that the best alternative to money may be resort to commodity credit, barter and own-production. Investment in interest-bearing assets can be of minor interest. A third departure, particularly important for late-medieval England, is the presence of great fluidity between labor for sale and for oneself. Joint integration of these three departures into a simple economic model permitted an econometric test of the long duration of the wealth effect of the Black Death. The confirmation is clear. The test also permitted significant sorting out of different factors in the behavior of the price level in fourteenth-century England – a problematic behavior that has piqued the interest of many medieval and early modern historians.

Let us go back to Figure 2a for the bare facts. The figure shows two sharp up and down swings of comparable duration for the century. The deflationary part of the first swing, 1320-47, brought the price level down around 30 percent. The deflationary part of the second one, 1370-1390, brought it down close to 20 percent. The first deflation, beginning during the great famine of 1317-22, was therefore the greater. According to the results, there is no single primary cause of both deflations. The wealth effect of the Black Death is the most likely one for 1370-90 and days worked for wages relative to total population is so for 1320-47. In 1370-90, as in 1352-1450 as a whole, the wealth effect on the English price level operated essentially by shifting tastes toward foreign goods. This shift is one that the Black Death set into motion.

The shift would easily explain deflation at home under the ruling monetary system. The same deflationary force evidently will not explain the 1320-47 deflation. Munro (2009) made a valiant effort to find a common cause for both deflations nonetheless by pointing to the drop in coinage both times. Yet, as we were able to show, this explanation is not satisfactory. Indeed, we show that coinage was probably mainly a reflection of the balance of payments in both periods and not an influence. This lack of influence is plain in our results.

In the case of 1325-47, two eligible factors for the deflation arise from the model and results: days of work for wages relative to the total population and population alone. However, only Days/Pop is really tenable. Population moved both ways. First it dropped and next it rose for comparable times, as we see from Figure 3. On the other hand, Days/Pop remained on a sharp fall from about 1325 all the way to 1347, as seen in Figure 4. Postan proposed population as an overarching influence on the price level in both deflations and the 14$^{th}$ century as a whole. It is interesting to weigh his proposition in light of the test results.

Apart from the population shock of 1348-51, population operated in two contradictory ways in the model. Its increases (at given output) were inflationary by raising aggregate demand for goods at the expense of real money balances. On the other hand, population growth reduced the importance of marketed goods in consumer budgets α as per capita output fell since non-marketed goods are income-inferior to marketed ones, and a fall in α tends to lower the price level (under the simplifying assumption of a constant relative price of marketed to non-marketed goods). There had been a grinding problem of maintaining consumption for decades reaching back to the 13$^{th}$ century prior to 1320-47 because of pressure on agricultural resources. As a result, cutting back on purchases of goods on the market in favor of self-sufficiency was often a salient choice. The tendency to go ahead and do so was in full swing in 1325-47, as seen in Figure 6. Higher population meant a heavier weight of non-marketed goods in the consumer basket, $1 - \alpha$, working toward a lower general price level, as just mentioned. Of course, the opposite tendency for higher population to raise the price level was also present. But the deflationary force prevailed in 1320-47. It is interesting that both inflationary and deflationary influences of population come out separately important in our results. Postan and his followers never separated the two. Their populationist argument for the 1370-90 deflation was fuzzier. It went little beyond contesting the role of money.

On the issue of the international application of our results for England, the literature offers strong indications that the English experience is a good reflection of the one in the rest of Northwestern Europe, that is, Holland, Brabant and Flanders. In addition, Herlihy (1997, pp. 46-47) shows that the English pattern of inflation followed by deflation after the Black Death was true of other parts of Europe, with inflation dominating all in all. Sumptuary laws, like the English ones, also showed up in Italy and other parts of Europe (Herlihy 1997, p.48). The

evidence of ostentatious consumption was broad. In addition, balance of payments deficits across different countries in Europe pose no problem of coherence, as they might seem to do, since there is strong evidence of net outflows of money from all of Europe to the Near East via Venice principally (Lopez et al 1970) and to an extent via easterly land routes to areas under Turkic domination and the Mongol empire. Since the Black Plague struck widely in Europe, the hypothesis of a long-lasting wealth effect makes sense. The durations of the effect might differ by country and the profiles of the wealth effect on the price level might differ too, but the basic hypothesis is sound.

Of course, caution matters. Standards of living varied and some Italian city-states were particularly rich and remained exporters of luxury products throughout the adjustment period. This clearly requires some adaptation of the model in those cases. A Spanish exception is also important. In its case, the Black Death strongly worsened an existing problem of scarce labor (Broadberry et al 2015, pp. 260, 370-2, 377-8, 424). While the wealth effect of the plague probably worked the right way, the plague's effect on factor proportions dominated and made matters worse. The clearest warning for caution comes from issues of social stratification. As land became relatively abundant because of the Black Death in East Germany, Poland and Russia, landowners were able to force common labor further into serfdom (Miskimin 1975, p. 61). Thus, rents did not fall and wages did not rise as in England and other large parts of Europe. In the aggregate, any positive impact of the wealth effect of the Black Death on survivors was probably offset by a poorer allocation of resources. The most disturbing example of a perverse effect comes from Egypt where standards of living were comparable to those in Europe before the Black Death, the epidemic hit hard, and there was no overabundance of labor. Yet in this country the Black Death set in motion a durable contraction of the economy as landowners joined forces to keep rents from falling at the cost of a higher percentage drop in output than labor (Borsch 2004). With falling income per head, labor fled into crowded cities instead of remaining as serfs as in Eastern Europe. In terms of first differences, the results were worse in Egypt than Europe.

In sum, there is wide scope for the hypothesis of the long duration of the wealth effect but reason to be wary too.

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## FIGURES

Figure 1: Per capita wealth index

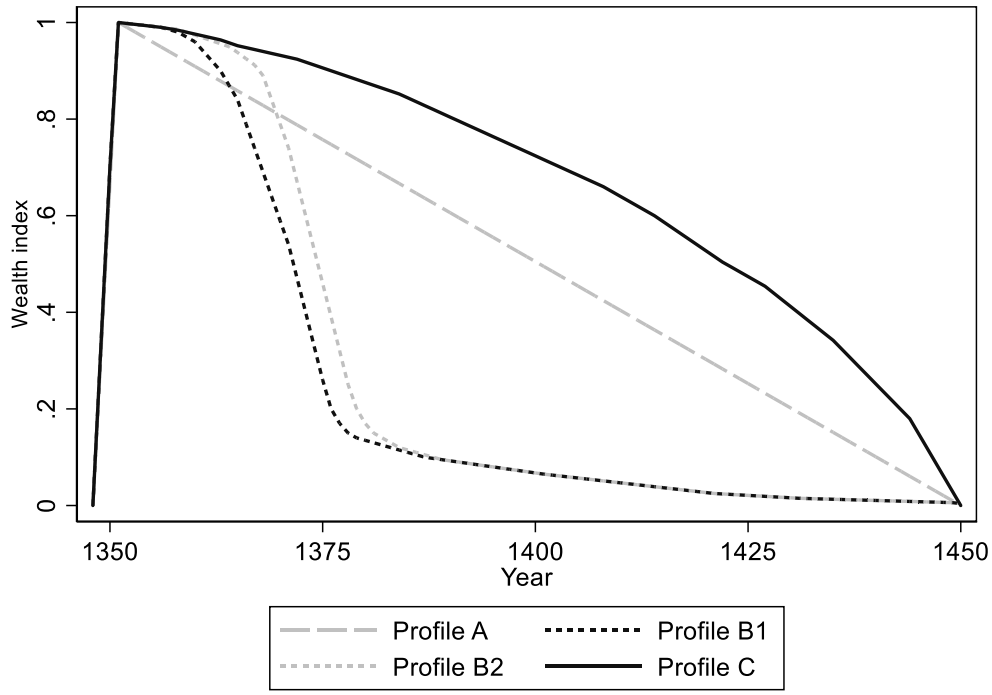



Figure 2a: Evolution of the price level

Figure 2b: Evolution of the price level (1335-1400)

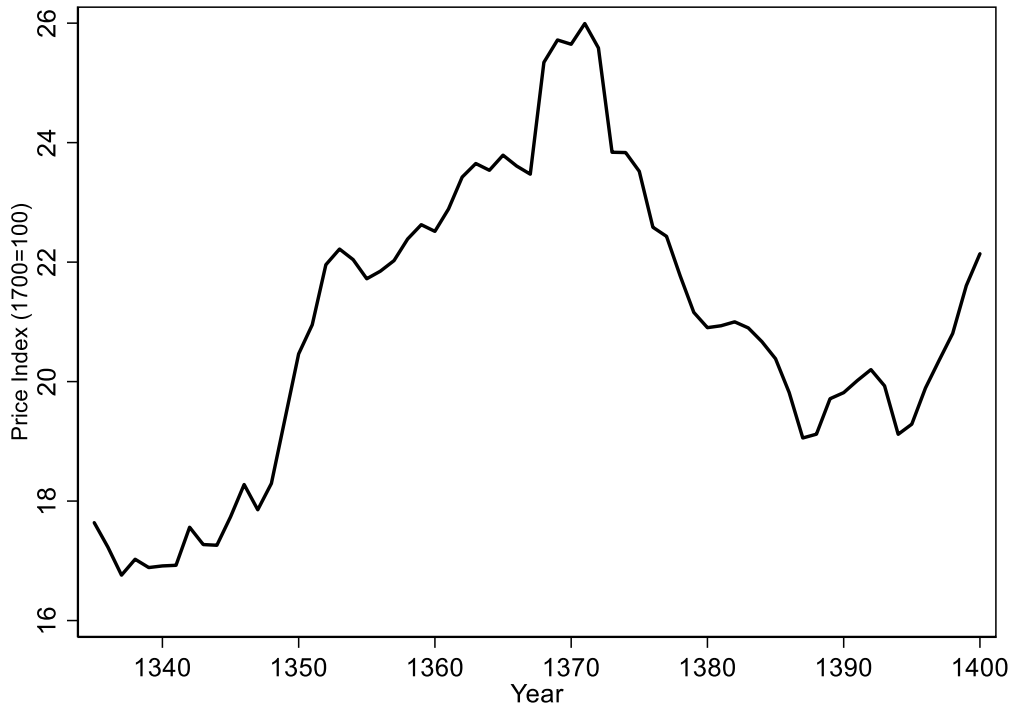



Figure 3: Population

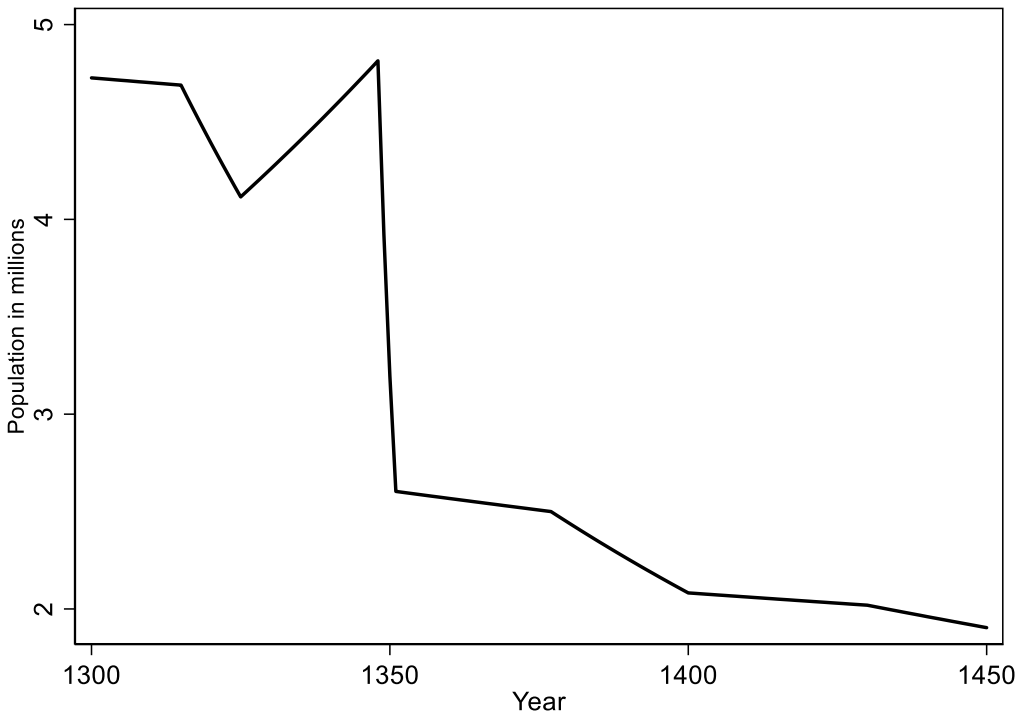


Figure 4a: Nominal wage

Figure 4b: Real wage

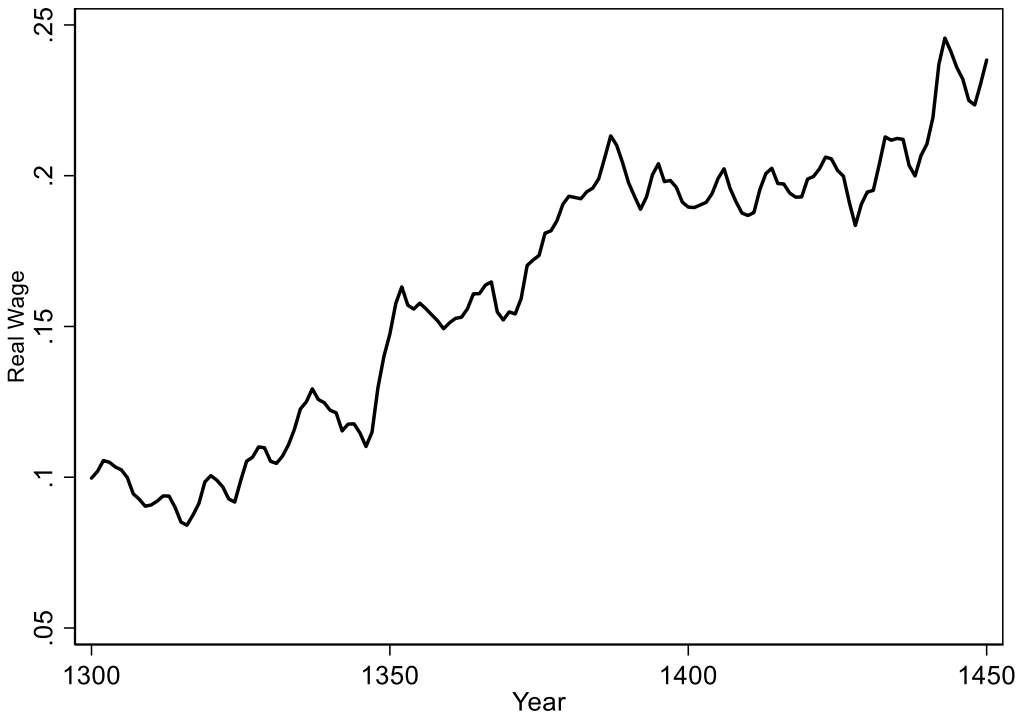


Figure 5a: Real output

Figure 5b: Real output per capita

Figure 6: Yearly days of work for wages divided by population

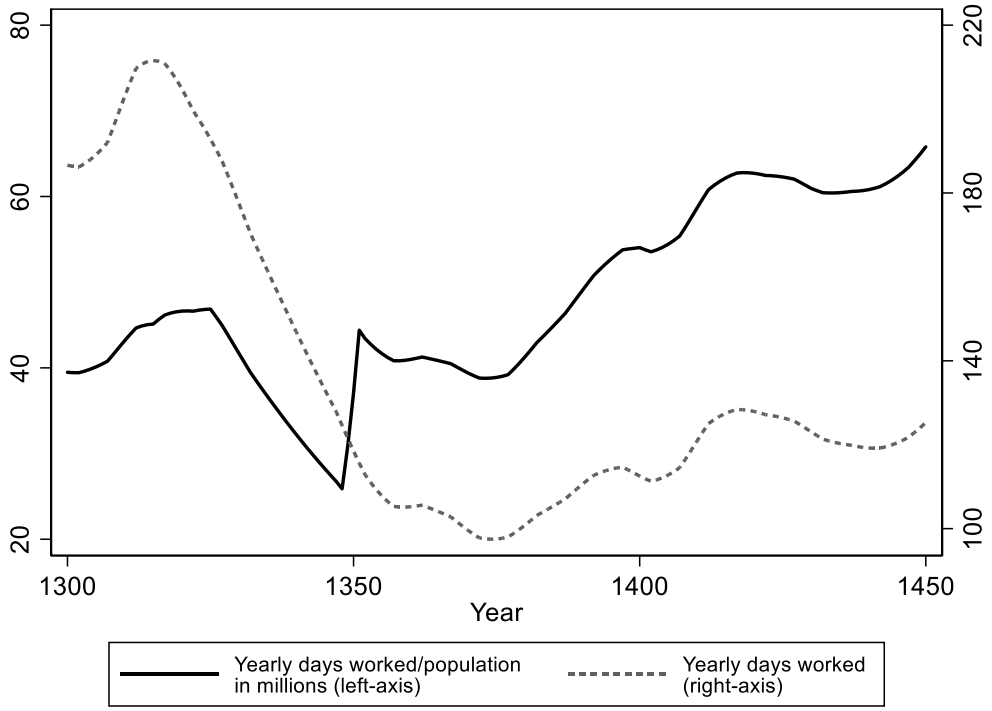
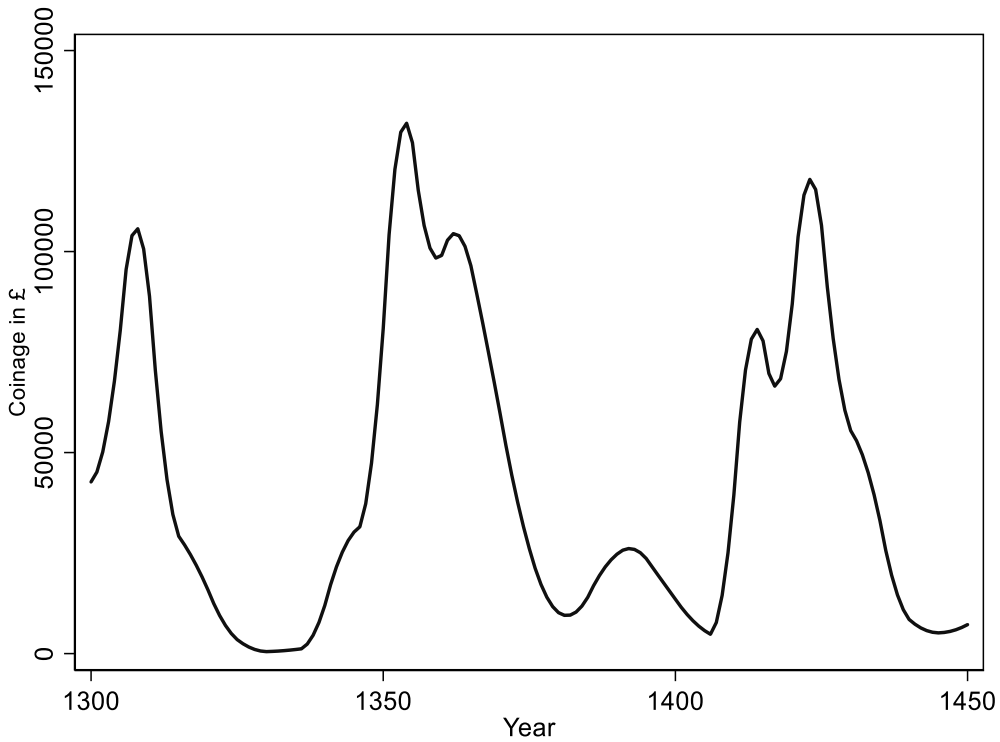



Figure 7a: Coinage from Palma

Figure 7b: Coinage from Munro



## TABLES

Table 1: Estimates with profile B2 ending year 1450 for wealth

| | Dependent variable: growth in prices | | | | | | |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Growth in wealth: Profile B2 | 0.024*** | 0.017*** | 0.019*** | 0.015*** | 0.046*** | 0.044*** | 0.047*** |
| | (7.71) | (9.24) | (4.61) | (5.34) | (4.43) | (5.43) | (6.04) |
| Lag growth in days worked/pop | 0.150*** | 0.067 | 0.149*** | 0.069 | 0.314*** | 0.249*** | 0.279*** |
| | (3.29) | (1.20) | (3.03) | (1.20) | (4.12) | (3.63) | (4.48) |
| Growth in output | - | - | -0.066* | -0.033 | -0.070** | -0.036 | -0.036 |
| | | | (-1.96) | (-1.14) | (-2.07) | (-1.27) | (-1.25) |
| Growth in population | - | - | - | - | 0.388*** | 0.425*** | 0.474*** |
| | | | | | (2.89) | (3.75) | (4.35) |
| 1352-1355 dummy | - | - | - | - | - | - | -0.011*** |
| | | | | | | | (-3.05) |
| Lag growth in prices | - | 0.449*** | - | 0.436*** | - | 0.441*** | 0.446*** |
| | | (6.15) | | (6.01) | | (6.10) | (6.12) |
| Observations | 151 | 151 | 151 | 151 | 151 | 151 | 151 |
| R-squared | 0.081 | 0.269 | 0.102 | 0.274 | 0.122 | 0.297 | 0.300 |

Note: The dependent and explanatory variables are computed using growth rate between t and t-1. The *t*-statistics in parentheses are based on robust (White) standard errors. Coefficients are statistically different from zero at the ***1%, **5%, and *10% level.

Table 2: Alternative profiles for wealth for ending year 1450

| | **Dependent variable: growth in prices** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Growth in wealth: Profile A | 0.021*** | - | - | - | 0.034*** | - | - | - |
| | (11.09) | | | | (5.63) | | | |
| Growth in wealth: Profile B1 | - | 0.024*** | - | - | - | 0.047*** | - | - |
| | | (8.21) | | | | (5.59) | | |
| Growth in wealth: Profile B2 | - | - | 0.024*** | - | - | - | 0.047*** | - |
| | | | (7.71) | | | | (6.04) | |
| Growth in wealth: Profile C | - | - | - | 0.021*** | - | - | - | 0.034*** |
| | | | | (11.86) | | | | (5.99) |
| Lag growth in days worked/pop | 0.153*** | 0.149*** | 0.150*** | 0.155*** | 0.218*** | 0.270*** | 0.279*** | 0.216*** |
| | (3.33) | (3.27) | (3.29) | (3.47) | (4.17) | (4.38) | (4.48) | (4.11) |
| Growth in output | - | - | - | - | -0.038 | -0.035 | -0.036 | -0.038 |
| | | | | | (-1.30) | (-1.22) | (-1.25) | (-1.30) |
| Growth in population | - | - | - | - | 0.337*** | 0.464*** | 0.474*** | 0.326*** |
| | | | | | (3.69) | (4.11) | (4.35) | (3.75) |
| 1352-1355 dummy | - | - | - | - | -0.008** | -0.011*** | -0.011*** | -0.008** |
| | | | | | (-2.55) | (-3.06) | (-3.05) | (-2.54) |
| Lag growth in prices | - | - | - | - | 0.453*** | 0.450*** | 0.446*** | 0.455*** |
| | | | | | (6.21) | (6.11) | (6.12) | (6.23) |
| Observations | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 |
| R-squared | 0.073 | 0.079 | 0.081 | 0.072 | 0.289 | 0.299 | 0.300 | 0.288 |

Note: The dependent and explanatory variables are computed using growth rate between t and t-1. The *t*-statistics in parentheses are based on robust (White) standard errors. Coefficients are statistically different from zero at the ***1%, **5%, and *10% level.

Table 3: Alternative profiles for wealth for ending years 1375 and 1400

| | **Dependent variable: growth in prices** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Ending year 1375** | | | | **Ending year 1400** | | | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Growth in wealth: Profile A | 0.028*** | - | - | - | 0.017 | - | - | - |
| | (2.89) | | | | (1.53) | | | |
| Growth in wealth: Profile B1 | - | 0.025** | - | - | - | 0.022** | - | - |
| | | (2.30) | | | | (2.10) | | |
| Growth in wealth: Profile B2 | - | - | 0.028*** | - | - | - | 0.022** | - |
| | | | (2.87) | | | | (2.04) | |
| Growth in wealth: Profile C | - | - | - | 0.006 | - | - | - | -0.014 |
| | | | | (0.37) | | | | (-1.25) |
| Lag growth in days worked/pop | 0.177*** | 0.163** | 0.175*** | 0.055 | 0.134* | 0.162** | 0.158** | 0.075 |
| | (2.65) | (2.27) | (2.64) | (0.58) | (1.74) | (2.22) | (2.17) | (0.88) |
| Growth in output | -0.043 | -0.043 | -0.043 | -0.047 | -0.042 | -0.042 | -0.041 | -0.044 |
| | (-1.46) | (-1.46) | (-1.46) | (-1.54) | (-1.44) | (-1.44) | (-1.41) | (-1.48) |
| Growth in population | 0.258** | 0.222 | 0.253** | -0.035 | 0.137 | 0.199 | 0.191 | -0.072 |
| | (2.03) | (1.63) | (2.03) | (-0.27) | (0.98) | (1.47) | (1.41) | (-0.64) |
| 1352-1355 dummy | -0.005 | -0.006 | -0.006 | -0.001 | -0.004 | -0.006 | -0.006 | -0.001 |
| | (-1.32) | (-1.35) | (-1.57) | (-0.13) | (-0.88) | (-1.38) | (-1.31) | (-0.19) |
| Lag growth in prices | 0.447*** | 0.451*** | 0.448*** | 0.442*** | 0.456*** | 0.453*** | 0.454*** | 0.440*** |
| | (5.96) | (6.03) | (5.99) | (6.02) | (6.13) | (6.09) | (6.12) | (5.97) |
| Observations | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 |
| R-squared | 0.280 | 0.279 | 0.285 | 0.259 | 0.266 | 0.273 | 0.272 | 0.261 |

Note: The dependent and explanatory variables are computed using growth rate between t and t-1. The *t*-statistics in parentheses are based on robust (White) standard errors. Coefficients are statistically different from zero at the ***1%, **5%, and *10% level.

Table 4: Estimates with profile B2 ending year 1450 for wealth: Adding coinage

| | Dependent variable: growth in prices | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Growth in coinage: Palma | 0.172*** | - | 0.092 | - | 0.101 | - |
| | (2.91) | | (1.54) | | (1.63) | |
| Growth in coinage: Munro | - | 0.010 | - | 0.001 | - | 0.005 |
| | | (0.98) | | (0.15) | | (0.63) |
| Growth in wealth: Profile B2 | - | - | 0.047*** | 0.047*** | - | - |
| | | | (6.39) | (6.07) | | |
| Lag growth in days worked/pop | - | - | 0.248*** | 0.277*** | 0.031 | 0.062 |
| | | | (4.65) | (4.48) | (0.33) | (0.70) |
| Growth in output | - | - | -0.036 | -0.036 | -0.045 | -0.047 |
| | | | (-1.25) | (-1.24) | (-1.54) | (-1.55) |
| Growth in population | - | - | 0.459*** | 0.471*** | -0.052 | -0.039 |
| | | | (4.54) | (4.42) | (-0.44) | (-0.35) |
| 1352-1355 dummy | - | - | -0.020*** | -0.011*** | -0.011 | -0.001 |
| | | | (-2.73) | (-3.03) | (-0.97) | (-0.19) |
| Lag growth in prices | - | - | 0.432*** | 0.445*** | 0.429*** | 0.442*** |
| | | | (5.98) | (6.06) | (5.93) | (5.98) |
| Observations | 151 | 151 | 151 | 151 | 151 | 151 |
| R-squared | 0.040 | 0.006 | 0.308 | 0.300 | 0.267 | 0.260 |

Note: The dependent and explanatory variables are computed using growth rate between t and t-1. The *t*-statistics in parentheses are based on robust (White) standard errors. Coefficients are statistically different from zero at the ***1%, **5%, and *10% level.

Table 5: Estimates with profile B2 ending year 1450 for wealth: Adding money wages

| | **Dependent variable: growth in prices** | |
|---|---|---|
| | (1) | (2) |
| Growth in money wages | 0.066** | 0.033 |
| | (2.20) | (0.91) |
| Growth in wealth: Profile B2 | 0.026*** | 0.046*** |
| | (3.85) | (5.42) |
| Lag growth in days worked/pop | - | 0.235*** |
| | | (2.63) |
| Growth in output | -0.033 | -0.036 |
| | (-1.17) | (-1.26) |
| Growth in population | 0.279** | 0.513*** |
| | (2.13) | (4.09) |
| 1352-1355 dummy | -0.025** | -0.022* |
| | (-2.12) | (-1.71) |
| Lag growth in prices | 0.447*** | 0.442*** |
| | (6.06) | (6.07) |
| Observations | 151 | 151 |
| R-squared | 0.287 | 0.304 |

Note: The dependent and explanatory variables are computed using growth rate between t and t-1. The *t*-statistics in parentheses are based on robust (White) standard errors. Coefficients are statistically different from zero at the ***1%, **5%, and *10% level.

Table 6: Other robustness tests

| | **Dependent variable: growth in prices** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Baseline sample period: 1300-1450** | | | | | | | | **1348-1450** |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Growth in wealth: Profile B2 | 0.047*** | 0.047*** | 0.047*** | 0.047*** | 0.047*** | 0.080*** | 0.044*** | 0.047*** | 0.042*** |
| | (6.04) | (6.13) | (5.93) | (6.04) | (5.98) | (3.78) | (6.62) | (5.91) | (7.13) |
| Lag growth in days worked/pop | 0.279*** | 0.273*** | 0.264*** | 0.277*** | 0.279*** | 0.259*** | 0.285*** | 0.279*** | 0.240*** |
| | (4.48) | (4.55) | (4.18) | (4.46) | (4.43) | (4.33) | (4.42) | (4.53) | (5.38) |
| Growth in output | -0.036 | -0.035 | -0.035 | -0.036 | -0.036 | -0.038 | -0.037 | -0.036 | -0.032 |
| | (-1.25) | (-1.24) | (-1.24) | (-1.25) | (-1.25) | (-1.33) | (-1.26) | (-1.25) | (-1.00) |
| Growth in population | 0.474*** | 0.454*** | 0.470*** | 0.469*** | 0.474*** | 0.550*** | 0.851* | 0.474*** | 0.393*** |
| | (4.35) | (4.28) | (4.31) | (4.33) | (4.33) | (4.42) | (1.71) | (4.20) | (5.42) |
| 1352-1355 dummy | -0.011*** | -0.010*** | -0.011*** | -0.011*** | -0.011*** | -0.011*** | -0.011*** | -0.011*** | -0.010*** |
| | (-3.05) | (-2.63) | (-3.09) | (-3.07) | (-3.09) | (-3.28) | (-3.01) | (-2.86) | (-2.97) |
| Lag growth in prices | 0.446*** | 0.440*** | 0.433*** | 0.447*** | 0.444*** | 0.435*** | 0.447*** | 0.446*** | 0.435*** |
| | (6.12) | (5.96) | (5.85) | (6.11) | (6.14) | (5.87) | (6.03) | (6.13) | (4.52) |
| Lag growth in mining | - | 0.030 | - | - | - | - | - | - | - |
| | | (0.74) | | | | | | | |
| Growth in government services | - | - | -0.031 | - | - | - | - | - | - |
| | | | (-0.78) | | | | | | |
| Great famine dummy: 1315-1322 | - | - | - | -0.002 | - | - | - | | - |
| | | | | (-0.18) | | | | | |
| Great famine dummy: 1315-1317 | - | - | - | - | 0.001 | - | - | - | - |
| | | | | | (0.05) | | | | |
| 1349 dummy | - | - | - | - | | -0.095* | - | - | - |
| | | | | | | (-1.89) | | | |
| 1349-1351 dummy | - | - | - | - | - | - | 0.076 | - | - |
| | | | | | | | (0.86) | | |
| Dummy: years>1348 | - | - | - | - | - | - | - | 0.000 | - |
| | | | | | | | | (0.00) | |
| Observations | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 103 |
| R-squared | 0.300 | 0.300 | 0.303 | 0.301 | 0.300 | 0.307 | 0.305 | 0.300 | 0.328 |

Note: The dependent and explanatory variables are computed using growth rate between t and t-1. The *t*-statistics in parentheses are based on robust (White) standard errors. Coefficients are statistically different from zero at the ***1%, **5%, and *10% level.

Table 7: Wald statistics from Granger causality tests

| | Single tests | | Joint tests of our full model | |
|---|---|---|---|---|
| | 1-lag | 1 to 3-lags | 1-lag | 1 to 3-lags |
| Growth in prices -> Growth in wealth: Profile B2 | 0.715 | 5.567 | 1.141 | 5.581 |
| | (0.398) | (0.135) | (0.286) | (0.134) |
| Growth in prices -> Lag growth in days worked/pop | 1.443 | 5.306 | 0.637 | 1.856 |
| | (0.230) | (0.151) | (0.425) | (0.603) |
| Growth in prices -> Growth in output | 0.004 | 1.722 | 0.0005 | 1.158 |
| | (0.948) | (0.632) | (0.983) | (0.763) |
| Growth in prices -> Growth in population | 0.278 | 3.874 | 0.020 | 5.980 |
| | (0.598) | (0.275) | (0.888) | (0.113) |

Note: Our variables are computed using growth rate between t and t-1. X -> Y indicates that we test the causality from X to Y. For each test, we report the Wald statistic based on the Granger causality test and the corresponding p-value in parentheses. For all tests, we accept the null hypothesis (i.e., the estimated coefficients on the lagged values of X are jointly zero and indicate no causal relationship) at the 10% level.