The effects of a resource boom on wealth and human capital in Madagascar

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Abstract

We examine the impact of a six-fold increase in the global price of vanilla on smallholder vanilla-farming households in Madagascar. The price increase causes sizable gains in wealth for a broad proportion of the rural population in vanilla-growing areas. While there is no effect on overall labor supply, vanilla producers are more likely to remain working in agriculture. The increase in wealth also leads to improvements in adult psychological well-being, cognitive performance, and optimism about the economy. Our findings indicate that windfall gains from positive price shocks can have substantial welfare impacts.

JEL codes: O12, O13, I15, I31, Q12

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1 Introduction

For many rural households in developing countries, off-farm labor market opportunities are limited, and the cultivation of cash crops provides one of the few pathways to expand their incomes beyond subsistence farming. As households increase their participation in cash crop production, their livelihoods become more closely connected to output markets, and changes in crop prices can have large impacts on their incomes. These changes in income can also affect other dimensions of well-being, such as health and education.

To shed light on the relationship between commodity prices and the well-being of agricultural households, we study a historically large and persistent increase in the price of vanilla. Between 2015 and 2018, the global price of vanilla increased more than six-fold. We analyze the impacts of this price change on vanilla farming households in Madagascar, which produces and exports around 80 percent of the world's vanilla crop. We first look at the extent to which the increase in international prices leads to changes in the wealth of smallholder households three to five years after the beginning of the price hike. Then we examine the effects on several dimensions of human capital, including the psychological well-being and cognitive skills of adults, as well as the health and education of children. By studying the effects on these other outcomes, we can gain insight into the broader question of the relationship between household economic circumstances and individual human capital. Our findings also help us learn about the prospects for rural households to benefit from the production of high-value crops, which has implications for policies aimed at promoting the production of export crops.

Although we might generally expect that higher world market prices will lead to higher incomes for producers, positive impacts may be limited or accompanied by important trade-offs[1]—particularly in a setting like Madagascar, which is one of the poorest countries in the

[1]The existing evidence from other contexts is mixed: Beck et al. (2018) and Adhvaryu et al. (2019b) find that international coffee price changes are transmitted to producer households in Vietnam and Tanzania, respectively, while Angrist and Kugler (2008) find only modest economic benefits in coca producing regions in Colombia.

world, with over 80 percent of the population living in extreme poverty in 2012 (World Bank, 2023b). Given the low level of market integration and limited access to information among small and isolated farmers living in remote regions that produce vanilla, middlemen may have substantial market power, which they can use to drive down the prices paid to farmers, and which could influence the pass-through of increases in the world price.[2] Although the evidence in this regard in Madagascar is limited, industry observers report that farmers may receive only 5 to 10 percent of the export value of their crop (Financial Times, 2018).

Even if the price increase does result in positive income shocks for smallholder producers, the expected impacts on other aspects of well-being are not clear *a priori*. We might expect higher income to lead to improvements in psychological well-being for adults, consistent with the evidence from evaluations of economic transfer programs (Haushofer and Shapiro, 2016; Hidrobo et al., 2020; Bossuroy et al., 2022; Romero et al., 2021). But there are several reasons why a crop price increase could lead to different effects. Higher prices could increase the time spent in vanilla-farming and therefore affect other dimensions of time use, including off-farm work or household chores. People may also perceive the income gains from commodity price volatility differently than income from other sources such as cash transfers, in a way that influences both how the funds are spent as well as psychological well-being.

The expected effects on children's and adolescents' human capital are likewise ambiguous. An increase in the return to income-generating opportunities does more than simply raise incomes: it also increases the opportunity cost of time-related investments in education and child health. This negative substitution effect, or "opportunity cost channel," could offset any positive income effects on human capital resulting from higher crop revenue. Indeed, several studies from the existing literature have documented negative effects on children's health (Miller and Urdinola, 2010) or educational attainment (Atkin, 2016; Carrillo, 2020;

[2]This situation has been observed elsewhere. In Guinea-Bissau, farm-gate prices of cashew nuts are a result of oligopsonistic competition, given a market concentration of traders who buy the cashew at the farm-gate, relative to a large number of smallholder cashew farmers (Cont and Porto, 2014), and in Côte d'Ivoire, much of the wealth from cocoa production has accrued to corrupt officials and the highly concentrated corporate sector (Merckaert, 2022).

Uribe-Castro, 2021; Kebede, 2022) as a result of increased returns to income-generating activities.[3] In contrast, evaluations of unconditional cash transfer programs, where the opportunity cost channel should not be relevant, generally do not find the same negative impacts; at the same time, many of these studies find effects on child outcomes that are small or insignificant, suggesting that the positive income effects can be modest, at least in the short run (Haushofer and Shapiro, 2016; Bastagli et al., 2019).

To address these questions, our empirical strategy exploits the rapid increase in the price of vanilla from less than USD 100 per kg in 2015 to a record high in 2018 of USD 600, a unit price comparable to that of silver. To identify the impacts, we combine information on the timing of the price change with variation in vanilla production across households and regions. Using a differences-in-differences design, we compare outcomes over time for vanilla producers and non-vanilla producers, and we also compare people living in vanilla-producing areas to those living in other regions. The identifying assumption is that the non-vanilla groups provide a good counterfactual for how vanilla producers or people living in vanilla areas would have fared in the absence of the price change. Because we have multiple rounds of data available prior to the shock, we can test for differential pre-trends across these groups.

Several additional features of this setting assist with our empirical identification. Individual vanilla farmers operate on a small scale, with little opportunity to influence the price. The price increase appears to be largely due to the increased demand for natural vanilla by global consumers (Steavenson, 2019), reflected in Nestlé USA's decision in 2015 to only use all-natural vanilla in its products (Nestlé, 2015; Reel, 2019), combined with the inelastic supply of vanilla. Since the time between planting and harvesting can take up to four years, farmers cannot quickly adjust output in response to price fluctuations, and households that

[3]The overall empirical evidence is mixed, and other studies have found a positive relationship with child outcomes. See Ferreira and Schady (2009) for a discussion of the literature on the effects of economic shocks on children's human capital. Beck et al. (2018) provide more recent evidence examining commodity prices changes in Vietnam, and Charris et al. (2024) analyze the income and substitution effects caused by tariff reductions in Brazil. Kebede (2022) finds that higher coffee prices lead to improvements in child malnutrition outcomes in coffee-producing households in Ethiopia but also lead to *lower* school enrollment for girls.

adopt vanilla in response to the price change would not see benefits for several years.

We use several datasets that straddle the price shock. Most important is a large panel survey, in which we collected a wide range of information since 2003 on over 1400 individuals who were around 30 years of age in 2019. These data include information about vanilla production at the household level, along with data on wealth, savings behavior, psychological well-being, cognition, and work. We also use data from several nationally-representative household surveys conducted before and after the price increase. In addition to data on household wealth and perceptions of economic well-being, these surveys contain information on a limited set of child education and health-related characteristics, allowing us to analyze the effects of the price shock on children. Unlike our panel survey, these data sets lack information on household vanilla production. We therefore merge in data on vanilla production at the community level and examine the effects of living in a vanilla-producing region.

One important concern is that the increase in vanilla revenue could also have effects on non-producers living in vanilla regions.[4] These households could potentially benefit if they are connected to producers through informal risk-sharing networks (Angelucci and De Giorgi, 2009) or if the local economy improves due to local multiplier effects (Egger et al., 2022); on the other hand, non-producer households could be negatively affected if the increase in vanilla revenue causes prices to increase (Filmer et al., 2023). We look for evidence of local spillovers on household wealth by comparing non-producers living in vanilla regions to non-producers living elsewhere. But for other outcomes, including those related to children's human capital, we cannot disentangle the direct versus indirect effects, and our aggregate estimates could be masking important heterogeneity within the vanilla regions.

Our main results are as follows. We first demonstrate that the increase in vanilla prices led to substantial increases in wealth among vanilla-producing households. Using an asset index, we observe a relative increase in average wealth of vanilla farmers ranging from 0.46 to 0.86

[4]The literature on cash transfers, for example, has documented evidence of indirect effects on non-recipients (Angelucci and De Giorgi, 2009; Cunha et al., 2019; Filmer et al., 2023; Egger et al., 2022).

standard deviations. We likewise observe a large shift in the vanilla region's overall wealth distribution: in vanilla-producing communities, the fraction of households with wealth levels above the national median rises by 20 percentage points. For non-producing households, we see no evidence of negative spillover effects on households assets; if anything, non-producers residing in vanilla regions see modest gains in wealth relative to people living elsewhere. Nonetheless, most of the wealth increase in vanilla regions appears to be driven by the direct gains to producers. In terms of employment, vanilla producers are more likely to remain working in agriculture, but there is no significant effect on total hours worked or overall employment status.

These increases in economic resources appear to translate into improvements in psychological well-being and cognition for vanilla farmers. Using a measure of the personality trait "emotional stability" as a proxy for psychological well-being, we find a relative increase in psychological well-being of around 0.4 standard deviations. People residing in vanilla-producing communities also report a relative increase in satisfaction with their living conditions and greater optimism about the economic conditions of the country. We additionally measure cognitive performance, using math and French tests, and find a relative increase in the math score for vanilla farmers of around 0.3 standard deviations, but no statistically significant effect on the French score.

Although we find several improvements in adult economic outcomes and well-being, we do not find evidence of substantial changes in human capital among children and adolescents—at least among the limited set of outcomes available in our data. We see no effects on schooling for older girls (age 15+), the only group for which education data are available both before and after the shock. We also see no differential changes in several inputs related to child health, including the use of antenatal care or care for fever symptoms, the fraction of children with a formal birth certificate, household access to sanitation and water, or the likelihood of reporting a lack of access to adequate food or medical care. There are multiple potential reasons for our failure to observe an impact of the increase in earnings on human capital outcomes for children, including the relatively short-term nature of our study, the specific and limited set of outcomes that we are able to observe, a lack of complementary infrastructure or investments, or negative spillovers on the non-vanilla households.

Our paper contributes to the literature examining the effects of cash crop prices on household well-being (Angrist and Kugler, 2008; Beck et al., 2018; Adhvaryu et al., 2019b; Kebede, 2022; Mekasha et al., 2022). Like many of these studies, we find that higher prices lead to economic benefits for producing households: despite the remote setting, high rates of poverty, and multiple levels of intermediaries in the value chain, the vanilla price shock led to a substantial increase in wealth for rural households in vanilla-growing regions. Our setting stands out due to the unusually large magnitude of the price shock and resulting increase in revenues, especially relative to the prior income levels of producers.

Our paper also contributes to the large literature examining the effects of income on human capital, including studies focused specifically on shocks to income-generating opportunities and the resulting effects on children's human capital.[5] In contrast to findings from Colombia (Miller and Urdinola, 2010; Carrillo, 2020; Uribe-Castro, 2021) and Brazil (Kruger, 2007), we see no evidence of negative effects through an "opportunity cost channel." This result is potentially consistent with the windfall nature of our income shock: in the short-term, producers benefit from higher farm-gate prices with little change in the amount of time spent working or caring for children.

We also contribute to the literature examining the effects of income shocks on psychological well-being.[6] Our estimated effects on the psychological well-being of adults are broadly

[5]In addition to the literature on commodity price fluctuations (Adhvaryu et al., 2019a,b; Beck et al., 2018; Carrillo, 2020; Cogneau and Jedwab, 2012; Kruger, 2007; Miller and Urdinola, 2010; Uribe-Castro, 2021; Kebede, 2022; Mekasha et al., 2022), the sources of economic shocks that have been studied are varied and include weather shocks, macroeconomic fluctuations, conflict, changes in trade policy, and plant openings.

[6]Studies examining the effects of crop prices on psychological well-being include Adhvaryu et al. (2019a) and Singhal and Tarp (2025). Other studies have analyzed the effects of economic transfers (Romero et al., 2021), currency devaluations (Hariri et al., 2015), and agricultural productivity (Christian et al., 2019).

consistent with the findings from evaluations of economic transfer programs (Romero et al., 2021), suggesting that the estimates from those studies may apply to income changes outside the context of transfer policies. One of the few other studies to examine the effects of changes in crop prices on psychological well-being is by Adhvaryu et al. (2019a), who find that cocoa price fluctuations in childhood affect long-run psychological well-being later in adulthood. By examining the short- to medium-run effects closer to the time of the shock, our results complement this existing literature. In particular, we observe sizable effects on household economic resources as well as parental well-being—two factors that can affect child outcomes later in life (Akee et al., 2018; Bennett et al., 2016; Baranov et al., 2020)—providing evidence about potential mechanisms behind longer-run impacts.

2 Vanilla production in Madagascar

Vanilla cultivation as a cash crop requires specific agroecological characteristics.[7] This limits production opportunities around the world and helps explain why Madagascar is the world's largest producer with an 80 percent global market share (O'Reilly, 2018). Within Madagascar, vanilla is only produced in the eastern coastal areas of the country, particularly in the northeastern region of Sava, with a small amount of production also in the Southeast. Other regions of the country, such as the highland areas of central Madagascar, are not suitable for production (Shriver, 2013). The map in Figure 1a shows the distribution of vanilla production in the country.

Vanilla producers in Madagascar are small-scale farmers, often in remote villages that are not accessible by roads. They are generally engaged in food crop production as well. Of the vanilla farmers in our sample, 88 percent also grow rice, 14 percent grow manioc, and just a small minority also grow other cash crops, namely cloves and peanuts. The median farm size for vanilla producers is 1 hectare, larger than the average of 0.5 hectares of other

[7]Several conditions need to be met, such as a temperatures of 20-23°C, evenly distributed annual precipitation of 1,500 mm or more with no extended periods of drought or heat, an altitude up to 600 meters above sea level, minimal winds, and soil pH value between 6 and 7 (Plant Village, 2022).

farmers. The median vanilla farmer uses half of their land (0.5 hectares) for vanilla.

Another distinctive feature of vanilla production is the long interval between initial planting and first harvest. The time between planting and pollination is as long as three years, and from pollination it takes from seven to nine months to harvest. Given the close to 4-year time span between planting and harvest, vanilla producers can only slowly increase production when faced with increased demand (O'Reilly, 2018).

The production of vanilla also has little economies of scale, as every step in the production process is highly labor-intensive. While in its native Central America the plant is pollinated by bees, in Madagascar vanilla requires hand-pollination. The pollination occurs between October and January, and the crop is harvested between June and August (Hansen et al., 2016). Between pollination and harvest, the plant requires pruning, fertilization, and disease management. The tasks related to the production, as well as the post-harvest processing, are relatively light physical labor requiring intricate handiwork; there is little advantage of a specific gender or age at any part of the production process, and labor on vanilla farms has traditionally been supplied by household members, with little hired labor (Cadot et al., 2008).

The output of the harvest is the green vanilla beans. Most farmers (95 percent) sell these directly to collectors at the farmgate (Shriver, 2013). Most collectors at farm gate are closely connected with a preparator, who cures the vanilla. The preparator sorts the beans according to quality before selling them to an exporter, who usually is responsible for the final post-harvest processing, which involves aging the vanilla.[8] The entire post-harvest process of curing and aging takes up to six months. Finally, the exporters contract with importers, who do the final packaging and sell the vanilla to wholesalers and retailers (Shriver, 2013).

Until 1993, the price of vanilla was determined centrally by Madagascar's Vanilla Mar-

[8]This curing process involves wilting the vanilla by submersing the beans in hot water for several minutes, after which they are dried in sun during the day time and then stored in boxed wrapped in blankets at night time until the beans acquire a deep brown color. In the aging process the dried beans are placed into closed boxes for up to six months.

keting Board (VMB). The abolition of the VMB led to price fluctuations for producers as the prices were set in global markets (Cadot et al., 2008). Figure 1b illustrates the dramatic increase in vanilla prices after 2015. The export price of vanilla was as high as USD 400 per kg in 2018, with retail prices climbing to USD 600 per kilogram. This is a remarkable increase from price levels that were consistently below USD 50 per kilogram until the mid 2010s. In 2019 among our sample, the revenue from vanilla was over 20 times that of cloves, another cash crop spice produced in Madagascar. Vanilla farmers reported earning a median of 8,000,000 Ariary in revenue in the last 12 months, equivalent to PPP-adjusted USD 7,130, which translates to USD 178 PPP per kilogram.[9]

3 Data

We employ several datasets collected both before and after the price increase: a long-term panel study with information on household-level vanilla production, several nationally representative household surveys, and a census of communes containing information on crop production at the community level. Appendix A provides more detail to these datasets, including their timing relative to the shock (Figure A1), outcome variables used in each dataset (Table A1), as well as details on variable construction.

3.1 Individual-level cohort panel

To analyze the impact of the vanilla price increase on vanilla producers, we use a dataset which follows a cohort of young adults who were surveyed in 2003-04 when they were young teens, then again in 2011-12 when they were around 20 years of age, and finally in 2019-20 when most were in their late twenties. We refer to this as the DEMTREND dataset.[10] The

[9]Without PPP adjustment this is 2,160 USD, which translates to 54 USD per kilogram produced using Google exchange rate of 1 USD = 0.00027 Ariary for October 1st 2019. The PPP-adjusted GDP per capita was USD 1,652 in 2019 (World Bank, 2023a).

[10]The individual survey waves are referred to as the Madagascar Life Course Transition of Young Adults Survey (for the 2011/12 and 2019/20 waves) and the Progression through School and Academic Performance in Madagascar Survey (or EPSPAM for the 2004 wave). See Glick et al. (2015) and Herrera Almanza et al. (2017) for additional details about the first two waves. For the 2019/20 wave, we attempted to contact all of the households included in

balanced panel includes extensive information on 1,346 cohort members with information on a range of life course transition outcomes, labor and time use, as well as tests of cognitive skills and non-cognitive personality traits. As our proxy for psychological well-being, we use the responses to the non-cognitive test questions to construct measures of emotional stability. Emotional stability is the name given to one of the "big five" personality traits and has been shown to be strongly correlated with subjective well-being, life satisfaction, and happiness (DeNeve and Cooper, 1998; Hills and Argyle, 2001; Winzer et al., 2021).[11] The surveys also include extensive information on the household, such as details on asset wealth and agricultural production. Summary statistics for the DEMTREND data are presented in Appendix Tables B1 and B2.

3.2 Repeated cross-sectional surveys

We combine data from several nationally representative household surveys to analyze the effects of the vanilla price shock in the communities producing vanilla. The first pooled cross-sectional dataset we construct combines four surveys: the UNICEF Multi Indicator Cluster Survey (MICS) collected in 2018, which contains extensive information on child well-being, is combined with three Malaria Indicator Surveys (MIS) collected in 2016, 2013, and 2011, which are collected within the Demographic and Health Surveys (DHS) project. These MIS surveys contain information on the demographic characteristics of the household, as well as a range of data on household living standards. The MIS surveys are more limited in terms of the range of questions relative to the full DHS survey, which limits the range of outcome variabes we are able to study with the repeated cross-section.

The outcome variables we are able to investigate given that they are common between

these earlier waves. See Section C.3 in the Appendix for more information about attrition.

[11]This trait is alternatively known as *neuroticism*, in which case the values take the opposite sign (thus representing a measure of emotional *in*stability). To measure the emotional stability of our cohort members (as part of a questionnaire designed to capture noncognitive or personality traits), we asked their agreement with a series of 19 statements, such as "I am often worried" or "I get easily frustrated." See Online Appendix A and Table A2 for more details about the variable construction and the list of survey questions used.

the three MIS surveys and the 2018 MICS are asset ownership, educational attainment of female household members over 15 years of age, information on the use of antenatal care services, and household access to water and sanitation. Since the MICS is wider in scope, we also utilize information collected by the MICS 2018 on child malnutrition, other indicators of child human capital, as well as various indicators of parental investment in children's human capital to investigate cross-sectional differences in these outcomes between vanilla regions and the rest of the country. The summary statistics for these data are shown in Table B3.

In addition to the MIS-MICS dataset, we analyze a separate dataset containing multiple waves of the nationally representative Afrobarometer surveys conducted in Madagascar for the years 2008, 2013, 2015, and 2018. These data are part of a pan-African series of national public attitude surveys on democracy, governance, and society. They also contain information on household economic outcomes, asset ownership, expectations about the economic situation, as well as basic necessities. Summary statistics for these data are shown in Table B4.

3.3 Commune-level data

To identify the vanilla-producing communities, we use geocoded information from the Commune Census, which included all communes in the country, conducted by the National Center for Applied Research for Rural Development (FOFIFA) and the National Statistical Institute (INSTAT) in 2007. Communes are the smallest identifiable geographical locality in the country. We classify a commune as vanilla-producing if vanilla is listed as one of the top 5 crops cultivated in the community, in terms of either value or land area cultivated. We use the GPS coordinates from our household survey datasets (DEMTREND, MIS-MICS, and Afrobarometer) to identify which clusters in these datasets are located in the vanilla-producing communes by matching Commune Census data to commune-level shapefiles.

4 Model

We examine the effects of the price shock using a difference-in-differences research design. Across all of our specifications, we rely on the assumption that the timing of the vanilla price shock is exogenous with respect to the small-scale producers. To capture the variation in exposure to the price shock, we utilize two different empirical strategies. First, using our DEMTREND individual-level panel data, we investigate the impact of the vanilla price shock for vanilla-producing households, where the comparison group is members of non-vanilla-producing households. Second, we examine the impact of the price shock on people living in vanilla-producing communities, where the comparison group consists of people living in other areas without vanilla production.

4.1 The effects of the price increase on vanilla farmers

For the analysis using the DEMTREND panel data that includes information on household-level vanilla production, we estimate a model that takes the form

$$Y_{ict} = \beta_1 Producer_i \times Post_t + \alpha_i + \omega_t + \varepsilon_{ict} \quad (1)$$

where Y_{ict} denotes outcome of individual (or household) i in enumeration area c and wave t. The variable $Producer_i$ takes a value of 1 if the household produces vanilla. The variable $Post_t$ takes a value of 1 for the 2019 survey wave—the only wave after the price increase—and 0 for the previous two waves (2003 and 2012). Individual fixed effects, denoted by α_i, capture time-invariant characteristics of the person (or household), and ω_t are dummies for the three waves of the panel. Standard errors are clustered at the community level c.

The identifying assumption in these analyses is that non-producers provide a good control group for characterizing how outcomes for vanilla producers would evolve in the absence of the price shock. While we cannot directly test this assumption, we can examine how our estimates change when we use different control groups. We run the analysis using three different comparison groups. First, we use the full sample, comparing vanilla producers to all other individuals in the survey. Second, we restrict our analysis to only those individuals living in vanilla-producing communities, comparing vanilla producers to nearby non-producing households. This comparison helps to address the concern that other region-specific shocks could be influencing our results, especially given the geographic pattern of vanilla production, which is largely concentrated in the northeastern part of the country (Figure 1). However, one limitation of this approach is that the presence of local spillovers to non-vanilla producers might lead us to underestimate the true effect. Third, we restrict our sample to agricultural households, defined as households that report any crop production or land under cultivation. The purpose of this sample restriction is to obtain a comparison group that is most similar to vanilla producers, in terms of capturing cohort members who may have had similar opportunities in life, but who do not all live in vanilla-producing communities. This specification is therefore our preferred one.

4.2 The regional effects of the vanilla price increase

For the analysis using repeated waves of cross-sectional household surveys (the pooled MIS-MICS dataset and the pooled Afrobarometer dataset), we use an event-study framework. Our model takes the form

$$Y_{icdt} = \sum_{k \in T} \beta_k Vanilla_c \times \mathbb{1}(k = t) + \delta_d \times Vanilla_c + \gamma_t + \alpha X_{it} + \varepsilon_{icdt} \qquad (2)$$

where Y_{icdt} denotes the outcome of household or respondent i residing in commune c and district d during year t. The variable $Vanilla_c$ takes a value of one if the household resides in a vanilla-producing commune. The coefficients β_k represent the event-study parameters and denote the effect of residing in a vanilla community during year k. The identifying assumption for this analysis is that vanilla and non-vanilla communities would have followed similar trends in the absence of the price shock, such that non-vanilla regions can be used to construct a valid counterfactual for the (treated) vanilla regions. The β_k parameter estimates for years before the price increase can be used to test for differential pre-trends, which would indicate a violation of the parallel trends assumption (Miller, 2023).

Additionally, district-level fixed effects (δ_d) capture time-invariant characteristics at the district level.[12] Since the surveys sample different households in each wave, we are unable to examine individual- or household-level changes over time. By including these district-level panel identifiers, our estimates are identified by comparing the within-district changes in average outcomes in vanilla-growing areas to changes in other areas of the country. To account for the fact that some districts contain both vanilla-producing and non-vanilla-producing communes, we interact the district fixed effects with the commune-level indicator for vanilla status. Finally, we include controls for demographic characteristics of the household denoted by X_{it}. We report regression results using population weights, and we cluster standard errors at the district level. Since the bulk of vanilla cultivation takes place in rural areas, we focus our analyses on rural households. This is in line with our preferred specification using the cohort panel, where we restrict the analysis to agricultural households.

We also estimate an aggregate differences-in-differences specification, where we interact the vanilla variable with an indicator for the post-shock waves:

$$Y_{icdt} = \beta_1 Vanilla_c \times Post_t + \delta_d \times Vanilla_c + \gamma_t + \alpha X_{it} + \varepsilon_{icdt} \tag{3}$$

In the analysis using the MIS-MICS dataset, $Post_t$ takes the value one for the 2018 survey and zero for the three earlier surveys in 2011, 2013 and 2016; for the Afrobarometer analysis, $Post_t$ equals one for 2018 and zero for 2008, 2013 and 2015.

Finally, we estimate an additional specification using our household panel data set that exploits the geographic variation in vanilla production. Instead of identifying off of differences in vanilla status across individuals as outlined in the previous section, we use the commune-level information on vanilla production to compare people living in vanilla-growing regions to people living elsewhere. Using an instrumental variables (IV) approach, we estimate the same specification displayed in Equation (1), except that we instrument individual-level

[12] As the MIS and the MICS datasets are repeated cross-sections using different communities across different waves, we do not necessarily have information on the same villages over time. In order to control for time-invariant characteristics for a geographical region, a district is the smallest common geographical unit that reliably contains information from each of the four cross-sectional datasets.

vanilla production using an indicator for whether the person resides in a vanilla-producing commune.[13] For this specification, we use the sample containing all agricultural households.

4.3 Threats to validity

As noted above, a key assumption is that the non-vanilla group provides a good counterfactual comparison for the vanilla group. In addition to testing for differential pre-trends, another useful feature of our analysis is that we can compare the results across our two empirical strategies. Because these strategies rely on different sources of variation in vanilla production, they differ in terms of identifying assumptions and corresponding potential threats to validity. For outcomes (such as wealth) that are common to both data sets, the results are broadly consistent, bolstering confidence in our findings.

One important threat to the validity of our results and interpretation relates to the possible presence of spillovers from 'treated' to 'non-treated' households. For the analysis comparing vanilla producers to nearby non-producing households, if non-vanilla households are also affected by the shock, the resulting estimates would be biased (due to violation of the stable unit treatment value assumption or SUTVA). For the analysis exploiting regional variation in production, the estimates would still be consistent even if non-vanilla households are also affected, so long as these spillovers are limited to local areas. But some caution is nonetheless warranted in interpreting those estimates, since the average effects represent a mix of the impacts on producers and non-producers alike. In Section 5.3, we look for evidence of spillovers on household wealth by combining our two sources of variation in vanilla production and examining the impacts on non-producers living in vanilla regions.

In section 5.4 and Online Appendix C, we examine the robustness of our results in more detail and discuss several additional threats to our identification, including selective attrition from the panel survey; selective migration into or out of the vanilla regions; and differential exposure to a damaging cyclone that hit the country in 2017.

[13] Specifically, we instrument the $Producer_i \times Post_t$ term with the interaction $Vanilla_c \times Post_t$, where $Vanilla_c$ is a commune-level indicator for whether vanilla is reported as one of the top 5 crops in the 2007 commune census.

5 Results

5.1 Economic outcomes

We begin by examining the effects of the price shock on household economic outcomes. We find that higher prices led to substantial increases in asset holdings for both vanilla farmers as well as for the population living in vanilla-producing communities and shifted labor supply towards farming activities.

5.1.1 Household wealth

First we examine the effect of the price increase on the wealth of vanilla producers. Table 1 displays the difference-in-differences results using the cohort panel dataset. The dependent variable is a household-level asset index, and we estimate the effect relative to the three comparison groups discussed in Section 4. Across all specifications, we see a large and statistically significant increase in household wealth. The asset index is normalized such that the distribution of the control group of non-producers in the full sample in the final wave has mean 0 and standard deviation of 1. The coefficient estimate in column 1 of Panel A therefore corresponds to a relative increase in the wealth of vanilla farmers of 0.46 standard deviations from the comparison group mean. We find slightly larger effects in magnitude—corresponding to a relative increase of 0.55 standard deviations—when we restrict the analysis to only households residing in vanilla-producing communities (Panel B).

In Panel C, we restrict the analysis to agricultural households only and find similar results, with an estimated increase of 0.45 standard deviations following the shock. This is our preferred comparison group, as it is likely to be most similar to vanilla-producing households.[14] Panel D displays the results from the IV specification that exploits the spatial variation in vanilla production; the coefficients remain significant and are substantially larger in magnitude.[15] Across specifications, the estimates are stable when we add controls (column

[14]The standard deviation of the asset index in the final wave for each of the three comparison groups is 1, 0.97, and 0.90, respectively.

[15]Part of the explanation for this difference is likely due to the fact that some vanilla-

2) and when moving to a household fixed effects specification (column 3).[16] We also look at changes in several other financial outcomes (in Appendix Table B5) and find that vanilla farmers are less likely to receive remittances, possibly indicating a lower need for assistance from their network; but we see no effect on the likelihood of sending remittances, having savings in a formal institution, or taking out a loan.[17]

Figure 2 displays event-study estimates for wealth following Equation (2) using the pooled MIS-MICS dataset and district-level fixed effects. Using data on vanilla production from the 2007 commune census, these estimates exploit the geographic variation in vanilla production and thus represent an "intent-to-treat" (ITT) effect, comparing average outcomes over time for the vanilla regions to other areas of the country. Wealth is measured by a household asset index, which is standardized relative to the mean and standard deviation of the non-vanilla communes in the post-period. We find a large and statistically significant increase in household wealth of 0.4 standard deviations in the full sample (panel a), which appears to be largely driven by rural areas (panel b). Within the vanilla-producing regions, a quarter of the survey clusters are defined as urban in the MIS-MICS datasets. In these areas, there is no statistically significant wealth increase as compared to other urban areas (panel c). These event-study figures display statistically insignificant pre-trends in all specifications. For our subsequent analyses, we restrict the sample to households residing in rural areas only.

In Table 2, we display the results of the difference-in-differences specification from Equation (3), where we interact the vanilla commune-indicator with a "Post" indicator for the

producing households in our sample live outside of those communes that are classified as vanilla-producing in the commune census. The low prevalence of vanilla production in these areas may reflect the poor agroecological suitability for vanilla, such that the vanilla producers in these areas are less likely to benefit from the price increase. The local average treatment effect (LATE) that we estimate in panel D is identified off of those vanilla producers living in communes where vanilla was one of the top 5 crops in 2007.

[16]Controls include both time varying and time-invariant variables, namely household size, whether the household is new, female household head (in 2012), highest grade attained by the cohort member in 2012, and the cohort members height (in cm in 2012).

[17]The results also indicate a significant increase in informal savings, but given the differential pre-trends for this outcome, we interpret this result with caution.

final 2018 survey round. The estimate in column 1 shows that households in vanilla communes experience a relative increase of 0.28 standard deviations in wealth following the price increase.[18] In columns 2–5, we analyze the effects on ownership of specific individual assets. We see a 16 percentage point increase for mobile phones (column 2), a 7 percentage point increase for motorcycles (column 3), and a 9 percentage point increase for radios (column 5), but no significant impact on ownership of bicycles (column 4). These are the four assets that are available in both the MIS-MICS and DEMTREND datasets; the corresponding results using the DEMTREND dataset show the same pattern, with significant increases in mobile phones, motorcycles, and radios, but insignificant effects on bicycles.[19]

The vanilla shock also leads to sizable changes along important thresholds of the welfare distribution. In 2012, an estimated 80.7 percent of the Malagasy population lived under the international poverty line. Given that assets can be used as a proxy for consumption-based measures of poverty (Brown et al., 2019) due to their strong positive correlation (Sahn and Stifel, 2003), we use this threshold to create an indicator variable on asset poverty, which is equal to 1 if the household is below the 80.7th percentile of the asset distribution. Column 6 of Table 2 shows that the price shock results in a 4.4 percentage point decrease in the probability of falling into asset poverty.

[18]For comparison, we use the DEMTREND panel to examine the effect of residing in a vanilla-producing commune. These estimates represent the "reduced form" of the IV specification in Table 1 (and are displayed in Appendix Table B8 Panels 1 and 2). In the sample containing agricultural households only, the estimated magnitudes are roughly similar to the coefficient estimates for the rural sample in Table 2: around 0.28 in the MIS-MICS vs. 0.33 in DEMTREND (Panel 1 of Table B8). Compared to the ITT estimates from Banerjee et al. (2015), who conducted poverty graduation programs in six countries with large transfer sizes, the magnitudes of our estimated effects for households in vanilla communities are slightly larger (around 0.34 SD in Panel 1 of Table B8 vs. 0.258 SD in Banerjee et al. 2015); the annual median vanilla revenue among vanilla producers is also slightly higher than their transfer size, 7,132 vs. 6,475 USD PPP (Appendix Figure B2).

[19]These results are displayed in Appendix Table B2. Also see Appendix Table B10 for the estimates for additional assets available in the MIS-MICS and Afrobarometer surveys.

5.1.2 Wealth Distribution

The sizable price shock may have altered the distribution of wealth in rural areas. For each household living in a vanilla commune, we determine their corresponding rank in the wealth distribution in non-vanilla areas in the same time period using the MIS-MICS. This allows us to display the wealth distribution for vanilla areas *relative to* non-vanilla areas, and then plot this relative distribution separately for the pre- and post-shock periods. We display one overall distribution for the pre-period by aggregating the three MIS pre-shock surveys.

The distribution of wealth in vanilla communes shifts substantially to the right after the price shock, as shown in Figure 3. Prior to the shock, wealth of the average rural household was slightly higher in vanilla areas: about 56% of rural households in the vanilla region fell in the top 50 percent of the rural (non-vanilla) wealth distribution. By 2018, this share increased by 20 percentage points to 76%. We can also compare these two distributions to estimate a lower bound on the proportion of households affected by the shock. In order to move from the first distribution to the second, it is necessary to increase the wealth ranking of at least 28 percent of the sample. This means that at least 28 percent of households living in vanilla communes experienced a relative increase in wealth, though the actual number could be much higher.

A factor contributing to these widespread benefits at the community level is the high level of engagement in vanilla production by a large share of the households in the vanilla producing regions. In the DEMTREND sample about 38 percent of households living in the vanilla-producing communes (as determined by the commune census) are producing vanilla in 2019-20, compared to less than 1 percent of households living in other communes. An alternative source of data results in similar findings: in the 2010 wave of the periodic household survey, 37 percent of rural households living in the vanilla communes report growing vanilla, compared to less than 1 percent of households in other areas.[20]

[20] This survey is known as the Enquête Périodique auprès des Ménages 2010 (EPM 2010) and it is conducted by the government of Madagascar. To determine which households lived in vanilla communes, we merged the EPM 2010 with data from our commune census.

5.1.3 Labor and time use

Next, we examine how the price rise affected vanilla farmers' labor allocation and time-use. Labor supply is overall increasing among the entire cohort between 2012 and 2019. Among vanilla-producing households, nearly all the cohort members report agriculture as an occupation, and while they are already more engaged in agricultural labor in 2012 than cohort members not producing vanilla, the gap widens over time: in 2019, 97 percent of cohort members report having an agricultural main occupation and having spent 91 percent of their working hours in agriculture during the previous 12 months, relative to other cohort members who spent just 34 percent of their time in agriculture (Appendix Table B1). The regression results corroborate these findings: Table 3 shows that while vanilla-producing cohort members are no more likely to be employed and work no more hours than non-producers as a consequence of the shock (columns 1 and 2), they start spending relatively more time working in agriculture than in other paid activities, and are more likely to report having an agricultural occupation (columns 3 and 4).

The price shock may have also led to changes in time-use outside of working hours. We first consider whether there is an impact on the time spent caring for children; a reduction in this time could be evidence of an opportunity cost effect relevant for child outcomes. We do not find strong evidence of such an effect: although the coefficient estimates are negative (Column 5 of Table 3), only one of them (Panel D) is statistically significant. We do however observe a statistically significant negative effect on time spent in other unpaid activities, by at least 40 minutes a day (column 6 of Table 3). In 2019, the average cohort member in a vanilla-producing household spent just 93 minutes per day in all unpaid household activities, while cohort members in non-vanilla households spent over 165 minutes in these tasks, a large widening in the gap between the two groups since 2012 (Appendix Table B1).[21]

[21] In addition to taking care of children; these tasks include housekeeping, repairs, laundry, grocery shopping and other household purchases, and preparing meals; fetching water; fetching firewood; taking care of the elderly; and, taking care of the sick.

5.2 Non-monetary well-being and human capital outcomes

Next we examine how the price rise and corresponding improvements in economic well-being relate to the non-monetary well-being of adult vanilla producers and whether there are downstream effects on children living in communities producing vanilla.

5.2.1 Adults' non-monetary well-being and cognitive performance

We first analyze data from the Afrobarometer surveys and find that the increases in wealth are accompanied by improvements in people's perceptions of the economy and their own economic well-being. The event-study results for these outcomes are display in Figure 4.[22] Following the vanilla price increase, respondents living in vanilla-producing areas are more likely to provide positive assessments of their own current living conditions, of the present economic conditions in the country, and of the changes in the country's economic conditions over the previous 12 months. And these positive assessments also correspond to greater optimism about the country's future economic trajectory: following the price shock, people in vanilla-producing areas are more optimistic in their expectations concerning the country's economic conditions over the next 12 months time. The event-study design used in Figure 4 confirms the statistically insignificant pre-trends across all four outcome variables.

We see similar patterns when we examine the psychological well-being of the respondents in the cohort panel. The results in Table 4 indicate that the price shock leads to improvements in the psychological well-being of adult members of vanilla-producing households. The dependent variables in columns 1 and 2 are measures of psychological well-being based on the numerical responses (from 1 to 5) to 19 questions from the DEMTREND non-cognitive (Big Five) questionnaire. Higher values of the variables indicate higher levels of "emotional stability."[23] Our main specification, which restricts the sample to agricultural households only (Panel C), results in statistically significant and sizable estimates: the coefficient in

[22]The corresponding difference-in-differences estimates are reported in Appendix Table B7.

[23]Column 1 uses the simple average across all 19 questions, while column 2 uses the first factor from confirmatory factor analysis. Appendix A and Appendix Table A2 provide the list of questions and the details to the variable construction.

column 1 translates to a relative increase of 0.45 standard deviations, and the estimate in column 2 translates to a 0.39 standard deviation increase from the comparison group mean. In Panel D, the coefficient estimates are again larger, over 1 standard deviation increase from the comparison group mean. When expanding the comparison groups to include non-agricultural households, however, the statistical significance declines: one of the estimates in Panel B is not significantly different from zero, and the other estimates in Panels A and B are only marginally significant, though similar in magnitude to those in Panel C. These magnitudes are large relative to the estimates reported in the literature on economic transfers to households (Romero et al., 2021), where the average effect size of receiving a transfer in low-and middle-income countries is 0.115 standard deviations.

Finally, we examine the data on cognitive test scores in the cohort panel. There are several channels through which the price shock could affect cognitive performance. Poverty can impede cognitive performance (Mani et al., 2013), thus a large income shock could result in improved cognition due to reduced cognitive load. And if higher prices lead to increases in work, this could also have a positive effect on cognitive skills (Jedwab et al., 2023). Cognitive function can also be affected by a change in stress levels (McEwen and Sapolsky, 1995; Comijs et al., 2011; Marina et al., 2011; Shields et al., 2017; McManus et al., 2022), although signing the impact of the price shock is difficult: it could reduce stress if vanilla farmers feel more financially secure, but could also lead to increased stress when crops need to be protected against theft.

While vanilla-farming cohort members have initially lower test scores than non-producers, a finding in line with their lower grade completion, the gap narrows in both math and French test scores between 2012 and 2019. The estimated impacts in Table 4 show that the shock has improved vanilla farmers' performance in the math test, but not in the French test. The estimated impacts on math scores correspond to relative increases of 0.36, 0.24, and 0.30 standard deviations (across Panels A, B, and C, respectively) with around twice the magnitude in Panel D relative to Panel C (consistent with results on other outcome variables). Indeed, French skills have improved across the entire cohort between 2012 and 2019, but math skills have improved only among the vanilla farmers, while they have stayed roughly at the same level for others (Appendix Table B1). The increase in math skills among vanilla farmers could potentially be due to greater interest or experience in agricultural sales and marketing to maximize vanilla revenue, or to overall reductions in stress, while the null effect on French skills may be due to the dominance of local languages in vanilla regions.[24]

5.2.2 Child and adolescent human capital

We also investigate whether the positive economic outcomes of the household combined with improved non-monetary well-being of adults had an effect on children's human capital and associated human capital investments. In contrast to our results above for adults, we generally find no significant effects on child and adolescent outcomes or investments in children and adolescents in vanilla-producing communities.

The vanilla shock may have altered the opportunity cost of schooling, although the sign of the effect is not clear a priori. On the one hand, increased incomes may lead to households having more resources to educate their children. On the other hand, the opportunity cost of schooling may be high if the alternative is supplying labor on farm. To examine the effects, we estimate a specification using the four waves of pooled MIS-MICS data for schooling and literacy for older girls. The 3 MIS waves only include information on education for women ages 15 and older. In order to isolate individuals in the final wave whose schooling could have been influenced by the price shock, we restrict our analysis to adolescent girls aged 15-19. The results in Table 5 indicate that there is no impact of the vanilla price shock on girls' years of education (column 1) or literacy (column 2).[25]

We also compare health outcomes across young children of different ages in 2018 using

[24]Furthermore, the finding is in line with Aubery and Sahn (2021) who find that unusually good harvests had a positive impact on math scores. Furthermore, language skills in adulthood are more strongly associated with the home environment in childhood than math skills are, indicating that math skills may be more malleable in adulthood (Kaila et al., 2023).

[25]The corresponding event-study estimates for years of education are displayed in Appendix Figure B3 and show that there is also no pre-trend.

the MICS data. Height and weight were collected for all children under five, from which we construct malnutrition indicators, namely stunting, wasting, and underweight, which indicate if a child is below 2 standard deviations from the WHO reference median in their height-for-age, weight-for-height, and weight-for-age, respectively. We also use these continuous variables to assess nutritional status of children.[26] We compare outcomes for children based on their date of birth. Because height-for-age is a stock variable reflecting cumulative health and nutritional inputs from in utero through the age of five, if the price hike has a positive effect, we would expect it to be higher (and stunting to be lower) among the younger children born after the price increase than for older children, who were born or in utero before the price-hike. Weight however, can fluctuate faster and thus we would not necessarily expect height-for-weight, weight-for-age, wasting, and underweight to vary considerably by age.

The results in Figure 5 indicate that children under five in vanilla regions had nearly precisely equally low health status compared to children in other rural areas of the country, regardless of whether they were born before or after the price shock. Similarly, we observe no differences in the rates of malnutrition.[27] Finally, for birth weight data available in MICS 2018 for the last two years, that is, during a period after the start of the price hike, we also do not find differences across vanilla and non-vanilla areas, nor a divergence in trends despite a strong concurrent upward trend in vanilla prices (Appendix Figure B4).

The similar health outcomes across vanilla and non-vanilla regions are in line with the findings in Section 5.1.3 above related to labor supply and time use. Parents do not appear to be increasing their hours worked or reducing the time spent caring for children in response to the shock.[28] We also examine several other inputs related to children's human capital. First,

[26]The MIS surveys collected before the shock do not include this information.

[27]This finding is confirmed by Appendix Table B11, that estimates a differences-in-differences regression, which interacts the vanilla community indicator with a variable denoting whether a child was under 24 months of age (as compared with 24-59-months-old), finding no statistically significant differences in any anthropometric variables.

[28]Descriptive comparisons across non-vanilla and vanilla regions using cross-sectional data from the MICS 2018 data on parental time use are in line with the findings from the panel showing little cross-sectional differences. These results are displayed in Appendix Tables B13

we examine changes in antenatal service use and antimalarial drugs taken during pregnancy using the MIS-MICS repeated cross-section. We find no effects on any type of antenatal care or on the receipt of any intermittent preventive treatment of malaria (IPTp) drugs as an antimalarial recommended during pregnancy, although we do find a decrease in the IPTp at the margin of 2 or more doses (Table 5 columns 3-7). Furthermore, using the MIS-MICS repeated cross-section, we find no increases in caring for a child with fever, and if anything, we find a decrease in the prevalence of sleeping under a bednet and bednet ownership, although no associated increase in the prevalence of fever among children (Appendix Table B12).[29] In line with the insignificant effect on antenatal care, we also find no effect on birth registration: using retrospective birth history information from the 2018 MICS for children born both before and after the price shock, there is no relative change in vanilla-growing regions in the likelihood of having obtained a birth certificate (Appendix Figure B5). The Afrobarometer results reported in Table 5 corroborate these results: there is no significant impact on the likelihood of reporting a lack of access to medicines or medical care (column 9). In terms of nutritional inputs, which can have an important impact on child anthropometric outcomes, Afrobarometer data show no effect on how often households report lacking enough food to eat (column 8).

The quality of water and sanitation can also affect children's health through bacterial contamination. Results from the MIS-MICS repeated cross-section show no changes in households' access to a toilet facility or to a protected water source (Appendix Table B15). Futhermore, the Afrobarometer data show no improvements in access to basic necessities such as clean water and cooking fuel, and also show that many households continue to report facing liquidity constraints despite the income shock (Appendix Table B16). Overall, the absence of significant effects on health-related inputs is consistent with a lack of improvements in

and B14.

[29]Malaria being seasonal, preventative measures may vary by month. This relative decline in preventative measures may be explained by the variation in survey months across the different MIS and MICS waves.

health outcomes.

Finally, another plausible explanation for the lack of improvements in children's health could be related to general equilibrium effects or spillovers on non-vanilla households through prices. In particular, if the vanilla shock leads to higher food prices in the vanilla region, this could negatively impact children's nutrition, as documented in Filmer et al. (2023) in the case of cash transfers. However, in the absence of consumer price data for the vanilla producing region, we are unable to test this hypothesis formally. We discuss the possibility of indirect effects in more detail in the next section.

5.3 Effects on non-producers

We use the DEMTREND panel to test for the presence of local spillovers on the wealth of non-producing households residing in vanilla-producing areas. Indirect effects on these households would lead to biased estimates in Table 1 above: negative spillovers on non-producers would cause us to overestimate the impact, while positive spillovers would lead to an underestimate. In Table 6 we display the estimates from specifications that combine the household-level variation in vanilla production with the spatial variation across communities. Specifically, we add the vanilla commune indicator to Equation 1 and interact it with both "producer X post" as well as "non-producer X post". This allows us to separately examine how outcomes evolve for producers and non-producers residing in vanilla communes relative to people living elsewhere.[30]

The results indicate that the increases in wealth in vanilla communes are driven almost entirely by the vanilla producers living in these areas. Using all households in the full sample, we find no statistically significant effect on wealth for non-producers living in vanilla communes. When we restrict the analysis to agricultural households, we do see some evidence of a positive effect for non-producers, though two of estimates are only marginally significant (at the 10 percent level), and the magnitude is a quarter the size of the impact on producers.

[30]For this analysis, we exclude the small subset of vanilla producers residing outside of vanilla communes.

While there is no strong evidence for large positive wealth spillovers on non-producers, the results in Panel C do allow us to rule out substantial *negative* spillovers: the lower bound on the 95 percent confidence interval in column 3 represents only a small decline of about 0.02 standard deviations. Taken together with the findings from Table 2 and Figure 3 that point to large increases in overall wealth of these communities, our evidence suggests that while benefits are widespread and sizable, they are strongly concentrated on vanilla producers with no conclusive evidence in support of spillover effects on non-producers.

In the absence of information on prices, we are unable to investigate the differential prices of assets in vanilla and non-vanilla regions. If the shock led to differential inflation in the vanilla region, which has been found in related literature on cash transfers (Egger et al., 2022; Filmer et al., 2023), the results above suggest that wealth effects for non-producers may have at least partially offset the negative impact caused by inflation. But the impacts on assets above do not rule out the possibility of different effects on other outcomes, such as food security or child health, especially if there are meaningful increases in food prices. Unfortunately we lack data on household consumption and on local prices, which would allow for a more thorough investigation of these indirect effects.

As long as any indirect effects are local to the district, the results from our earlier analyses that exploit spatial variation in vanilla production would be consistent. But since our MIS-MICS and Afrobarometer datasets lack household-specific information on vanilla production, we cannot perform the same test of spillovers for those outcomes. Our estimated average impacts could be compatible with either positive or negative impacts on non-producing households.

5.4 Robustness checks

We estimate several additional specifications to examine the robustness of our findings and investigate specific threats to validity. The estimation results and additional details are provided in Online Appendix C. One concern is related to the timing of the vanilla price increase relative to the survey dates and subsequent impacts. For our main specifications, we include the 2016 MIS wave in the pre-period, but our findings are robust to several alternative specifications, including: using the vanilla price as a measure of treatment intensity instead of year dummies, including the 2016 MIS wave in the post-period, or omitting the 2016 data entirely (Appendix Tables C1–C3). Given the regional concentration of vanilla production, another concern is that other shocks to the vanilla region could be influencing the set of estimates that rely on spatial variation in production. In particular, a cyclone hit the vanilla-growing region in 2017; we show that the main estimates are robust to alternative specifications in which we account for the exposure to the cyclone using geocoded information (Appendix Table C4).

Another potential threat to validity concerns selective migration or attrition from the sample. The analysis using repeated cross-sections does not allow us to track specific individuals or households over time. But the final survey in 2018 does include information on how long people have lived at their current residence, and we do not see significant cross-sectional differences across regions in the fraction of people that have moved in during the past few years (Appendix Table C5). For the DEMTREND panel, we are able to track individuals over time. But because some variables are measured at the household level, our estimates could be biased if household formation is affected by the shock. To investigate this possibility, we estimate several specifications that incorporate information on whether the cohort member has changed households over time and find that the main results are robust (Appendix Table C6). Finally, we show that the main findings from the panel regressions are robust to adjustments for selective attrition (Appendix Table C7).

6 Concluding remarks

The findings in this paper contribute to the long-standing debate on the extent to which export crop production can lead to improvements in living standards and well-being for the rural poor. For countries with high levels of poverty and large parts of the population engaged in agricultural production, efforts to promote the production of export crops offer a potentially attractive strategy for economic development. Export crop cultivation can provide households with a high-value income-generating opportunity that is less dependent on local demand. It also exposes them to income shocks driven by changes in international prices. In our setting, we see how positive increases in crop prices can lead to substantial gains for producing households.

A limitation of our analysis is that we are not able to analyze the impacts of the shock over the long-term. Although we see improvements in wealth and certain measures of human capital for adults, the set of outcomes that we analyze related to child health and schooling show no significant changes. One potential explanation could be that impacts on certain child-related outcomes take longer to materialize. Adhvaryu et al. (2019a), for example, find significant long-run effects of childhood exposure to fluctuations in cash crop prices. When (Agness and Getahun, 2024) examine the longer-term effects of a housing lottery in Ethiopia, they find significant increases in the human capital outcomes of children eight years later, but they note that these effects take time to materialize and would therefore be missed in short-term evaluations. In our setting, we see substantial near-term impacts on household economic resources and parental well-being, which could have important downstream effects: the improvements in adult cognitive skills and emotional stability could further increase their earnings potential and improve the household environment and parental relationships experienced by children. And the asset accumulation could translate to increased resilience against negative shocks. Understanding the long-run effects of cash crop cultivation and associated income shocks will be critical to inform policies affecting farming communities that are connected to global value chains and is an important topic for future research.

Data Availability Statement

Data and code to replicate the results in this paper will be deposited in an online repository.

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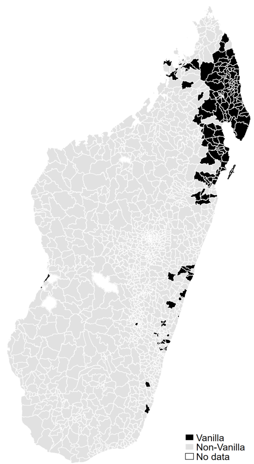
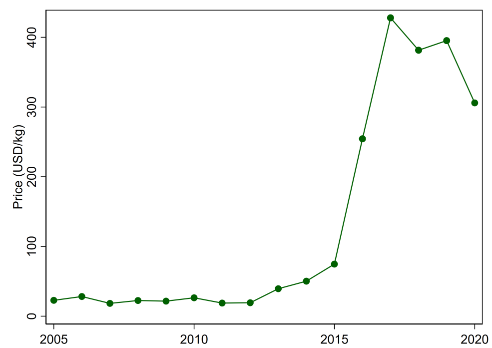
Figure 1 – Vanilla production in Madagascar and global vanilla price

(a)

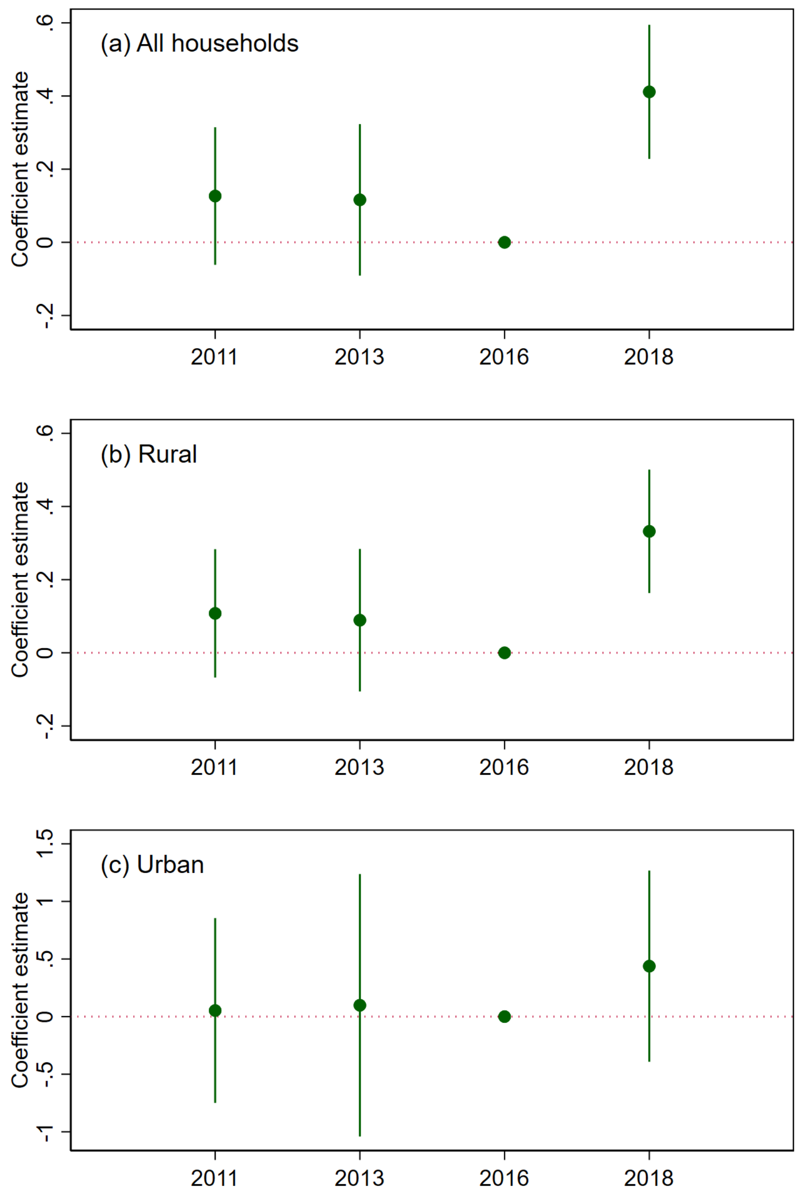


(b)



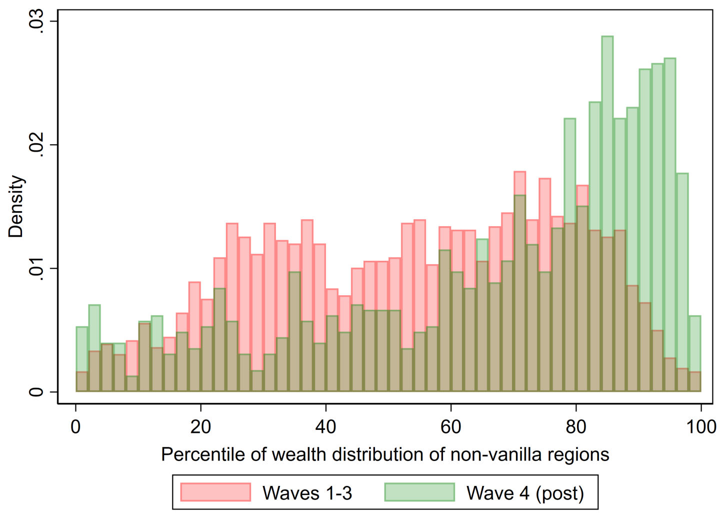
Source: (a) 2007 commune census; (b) Authors' calculations using COMTRADE database. *Notes:* Panel (a) displays the geographic distribution of vanilla production in Madagascar. Vanilla-producing communes (shown in black) are those where vanilla is reported among the five most common crops produced in the community, either measured by the land size devoted to vanilla production, or in terms of income generated. Panel (b) displays the average value of a kilogram of vanilla exported from Madagascar at the annual level for 2005-2020 expressed in USD.

Figure 2 – Wealth index in vanilla-producing regions relative to non-vanilla regions



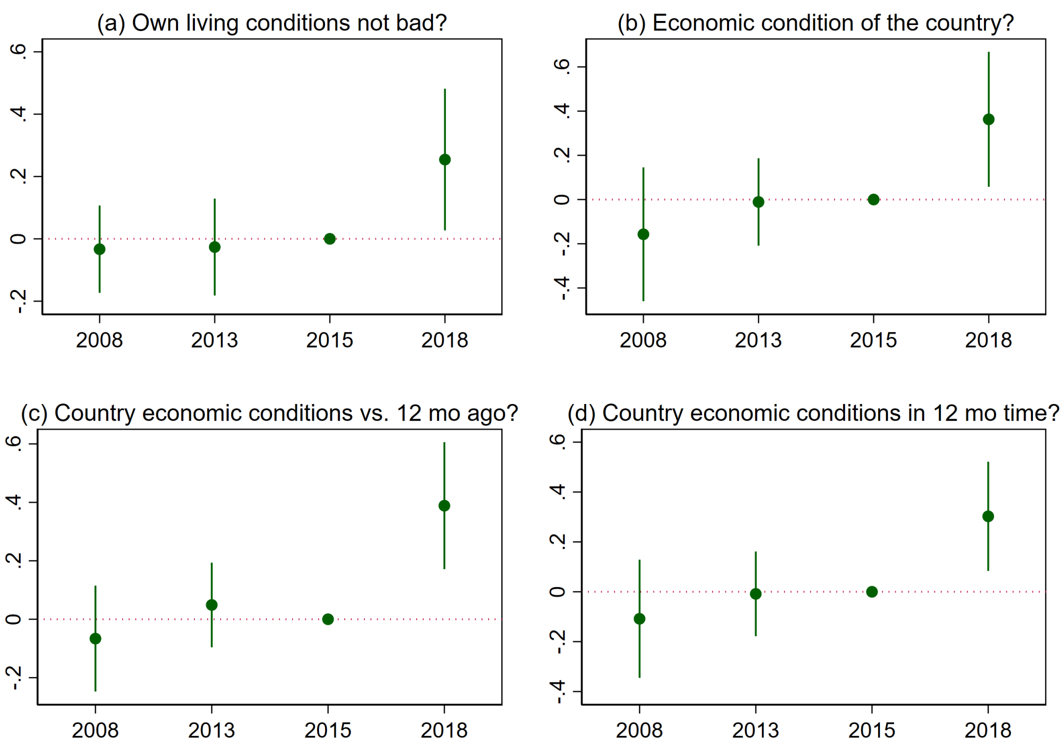
Source: Data used is the MIS & MICS 4-wave repeated cross section.
Notes: Estimates are from an individual-level regression containing district and survey-year fixed effects and household controls. Each marker represents the point estimate and 95% confidence interval from the interaction between the vanilla-commune and survey-year indicators. "Vanilla commune" indicates that vanilla was reported as one of the top 5 crops in the commune census. See notes to Table 2 for the list of control variables. The p-values for tests of joint significance of the pre-period coefficients are 0.39, 0.48, and 0.99, respectively.

Figure 3 – Distribution of household wealth in vanilla-growing regions before and after the vanilla price shock



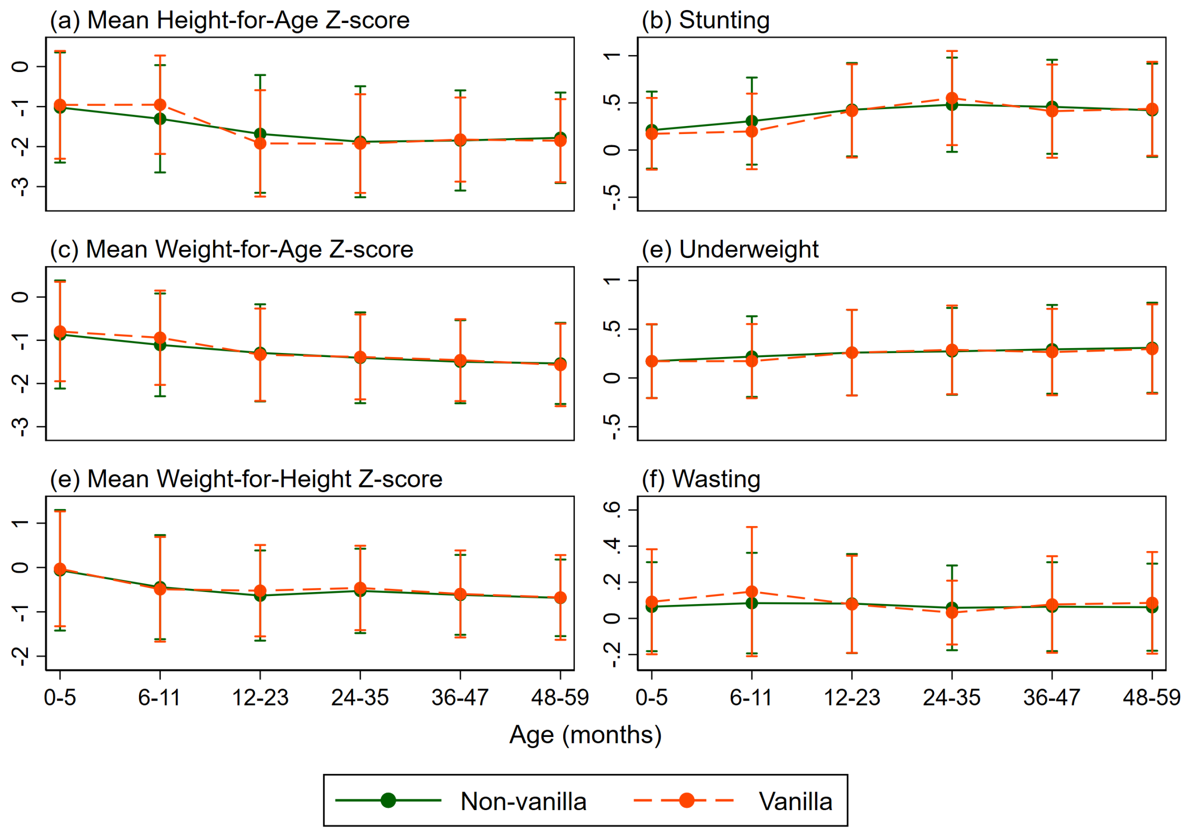
Source: Data used is the MIS & MICS 4-wave repeated cross section; rural sample only.
Notes: For each household residing in a vanilla-growing commune, we compare the value of their wealth index to households living in non-vanilla-growing communes to determine their corresponding position in the non-vanilla wealth distribution. The figure plots the histograms of this relative wealth measure for vanilla-growing areas prior to the price increase (Waves 1-3) and after the price increase (Wave 4). After the price increase, there is a large shift to the right in the wealth distribution for vanilla-growing areas relative to non-vanilla areas.

Figure 4 – Perceptions of economic well-being in vanilla-producing regions: selected outcomes



Source: Data used is the Afrobarometer survey; rural sample only.
Notes: Estimates are from an individual-level regression containing district and survey-year fixed effects. Each figure displays the point estimates and 95% confidence intervals from the interaction between an indicator for vanilla-growing commune and survey-year fixed effects. The outcome variable for the specification is indicated in each panel. "Own living conditions not bad?" equals 1 for respondents who rated their own present living conditions as *very good*, *fairly good*, or *neither good nor bad*, as opposed to *fairly bad* or *very bad*. "Country economic conditions not bad?" is coded the same way, in response to a questions about the present economic conditions in this country. "Country economic conditions vs. 12 mo ago?" is an indicator equaling 1 if the respondent answered *same*, *better*, or *much better* to the following question: "Looking back, how do you rate economic conditions in this county compared to twelve months ago?"; it is 0 if the response is *worse* or *much worse*. "Country economic conditions in 12 mo time?" is coded similarly, in response to the question: "Looking ahead, do you expect economic conditions in this country to be better or worse in twelve months time?" The p-values for tests of joint significance of the pre-period coefficients are 0.88, 0.28, 0.50, and 0.59, respectively.

Figure 5 – Child anthropometry in 2018 in vanilla-growing and non-vanilla-growing regions



Source: Data used is the MICS 2018 survey; rural sample only.
Notes: The figures display average Z-scores and average rates for three indicators of child malnutrition (stunting, wasting, and underweight) by age group for children living in vanilla communes and non-vanilla communes in 2018; error bars indicate +/- 1 standard deviation.

Table 1 – Wealth of vanilla producers

	(1)	(2)	(3)
Panel A. Full Sample			
Vanilla producer × post	0.455***	0.449**	0.462***
	(0.171)	(0.183)	(0.171)
Vanilla producer	-0.306**	-0.341***	
	(0.116)	(0.0949)	
N	4113	3723	4099
Mean of dep. var.	-0.000	0.012	-0.000
Panel B. Restrict to vanilla communes			
Vanilla producer × post	0.553***	0.558***	0.551***
	(0.172)	(0.186)	(0.173)
Vanilla producer	-0.314**	-0.396***	
	(0.124)	(0.124)	
N	872	805	872
Mean of dep. var.	-0.206	-0.172	-0.206
Panel C. Restrict to agricultural households			
Vanilla producer × post	0.453**	0.437**	0.457***
	(0.172)	(0.183)	(0.172)
Vanilla producer	-0.227**	-0.286***	
	(0.106)	(0.0912)	
N	3185	2933	3179
Mean of dep. var.	-0.235	-0.210	-0.235
Panel D. IV, restrict to agricultural households			
Vanilla producer × post	0.860***	0.881***	0.855***
	(0.184)	(0.202)	(0.188)
N	2520	2326	2520
Mean of dep. var.	-0.291	-0.273	-0.291
First stage F stat	21.9	22.5	21.9
Controls	No	Yes	No
Wave FE	Yes	Yes	Yes
Zone FE	Yes	Yes	No
Household FE	No	No	Yes

Source: Data used is the DEMTREND cohort panel.
Notes: The dependent variable is the household asset index, which is standardized by the mean and standard deviation of the non-vanilla producing households in wave 3. "Vanilla producer" is a household-level indicator of vanilla production, and "Post" is an indicator for wave 3. The interaction term in Panel IV is instrumented using the interaction between "Vanilla commune" and "Post". Robust standard errors in parentheses, adjusted for clustering at the community level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 2 – Wealth in vanilla-producing regions

		Specific Assets				
	(1) Wealth index	(2) Mobile Phone	(3) Motorcycle	(4) Bicycle	(5) Radio	(6) Asset poverty
Vanilla commune × post	0.277***	0.159***	0.0700***	-0.0263	0.0896**	-0.0438**
	(0.0606)	(0.0379)	(0.0246)	(0.0232)	(0.0411)	(0.0214)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Wave FE	Yes	Yes	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes	Yes	Yes
N	32465	32380	32271	32269	32269	32465
Mean of dep. var.	-0.284	0.403	0.0202	0.167	0.413	0.947

Source: Data used is the MIS & MICS 4-wave repeated cross section; rural households only.
Notes: The dependent variable is: the household asset index (col 1); an indicator for whether someone in the household owns the particular asset specified (cols 2-5); and an indicator for whether the asset index is below the 80^{th} percentile. "Vanilla commune" indicates that vanilla was reported as one of the top 5 crops in the commune census, and "Post" is an indicator for the fourth round of data in 2018. All specifications include district fixed effects, which are also interacted with the vanilla indicator. Controls include the age, number of births, and literacy status of the respondent, along with dummies for catholic, protestant, and no religion. Population weights are used in each regression. Robust standard errors in parentheses, adjusted for clustering at the district level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3 – Labor outcomes of vanilla producers

	Worked in last 12 mos		Agriculture		Unpaid work (mins/day)	
	Worked (1)	Hours (2)	Agriculture occupation (3)	Hours in agriculture (4)	Caring for children (5)	All other activities (6)
Panel A. Full Sample						
Vanilla producer × post	-0.0571	84.47	0.162***	619.6***	-14.43	-40.48**
	(0.0832)	(195.4)	(0.0529)	(165.2)	(11.55)	(16.41)
N	2488	2634	1902	2618	2480	2546
Mean of dep. var.	0.901	1466.6	0.550	508.0	51.16	115.7
Panel B. Vanilla Communes						
Vanilla producer × post	-0.0730	-180.8	0.0907	440.6**	-11.54	-44.75**
	(0.0808)	(216.7)	(0.0590)	(182.4)	(15.74)	(21.82)
N	544	554	422	550	544	548
Mean of dep. var.	0.934	1563.7	0.687	623.0	47.55	108.1
Panel C. Restrict to agricultural households						
Vanilla producer × post	-0.00278	152.9	0.184***	630.0***	-16.04	-40.26**
	(0.0833)	(197.6)	(0.0545)	(167.7)	(11.75)	(17.77)
N	1960	2070	1642	2056	1936	1984
Mean of dep. var.	0.921	1469.4	0.635	642.0	51.58	119.9
Panel D. IV, restrict to agricultural households						
Vanilla producer × post	-0.0643	545.9*	0.117	971.6***	-69.20**	-87.54**
	(0.130)	(282.6)	(0.124)	(210.1)	(31.48)	(34.59)
N	1532	1602	1286	1590	1508	1546
Mean of dep. var.	0.924	1480.7	0.681	699.1	54.05	123.1
First stage F stat	21.0	20.7	21.7	22.3	21.1	21.2
Wave FE	Yes	Yes	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	Yes

Source: Data used is the DEMTREND cohort panel.
Notes: The dependent variable is: an indicator for the cohort member's work status (col 1); total hours spent working in the last 12 months (col 2); an indicator for whether the main occupation is agriculture (col 3); total hours spent working in agriculture in the last 12 months (col 4); and total minutes per day spent caring for children (col 5) or doing other categories of unpaid household work (col 6, see text for description). Robust standard errors in parentheses, adjusted for clustering at the community level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4 – Psychological well-being and cognitive test scores of vanilla producers

	Emotional Stability		Cognitive Tests	
	(1) Average	(2) Factor	(3) French	(4) Math
Panel A. Full Sample				
Vanilla producer × post	0.208*	0.355*	0.0249	0.0731***
	(0.107)	(0.199)	(0.0336)	(0.0255)
N	2366	2366	2386	2386
Mean of dep. var.	3.516	0.00303	0.559	0.424
Panel B. Vanilla Communes				
Vanilla producer × post	0.222*	0.360	0.00420	0.0519**
	(0.115)	(0.217)	(0.0439)	(0.0215)
N	464	464	514	514
Mean of dep. var.	3.439	-0.105	0.520	0.388
Panel C. Restrict to agricultural households				
Vanilla producer × post	0.215**	0.362*	0.0130	0.0663**
	(0.107)	(0.199)	(0.0352)	(0.0265)
N	1862	1862	1844	1844
Mean of dep. var.	3.488	-0.0414	0.516	0.394
Panel D. IV, restrict to agricultural households				
Vanilla producer × post	0.614***	1.041***	0.114	0.130*
	(0.198)	(0.322)	(0.0871)	(0.0749)
N	1436	1436	1438	1438
Mean of dep. var.	3.482	-0.0510	0.498	0.380
First stage F stat	27.0	27.0	16.9	16.9
Wave FE	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes

Source: Data used is the DEMTREND cohort panel.
Notes: The dependent variables in columns 1 and 2 are measures of psychological well-being based on the numerical responses (from 1 to 5) to 19 questions related to "emotional stability" from the non-cognitive (Big Five) questionnaire: column 1 uses the simple average across all 19 questions, while column 2 uses the first factor from confirmatory factor analysis; higher values indicate higher levels of "emotional stability" or, equivalently, lower levels of "neuroticism". The dependent variable in the final two columns is the average of the cohort member's score across the oral and written tests in French (column 3) or math (column 4). Robust standard errors in parentheses, adjusted for clustering at the community level. * p < 0.10, ** p < 0.05, *** p < 0.01.

Table 5 – Female education, antenatal care, and access to basic necessities in vanilla-producing regions

	Female education		Antenatal care					Often gone without	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Years	Literacy	Any ANC	Formal ANC	Informal ANC	Any IPTp	2+ doses IPTp	Enough food to eat	Medical treatment
Vanilla commune × post	0.0420	-0.0294	-0.0322	-0.0253	-0.00141	-0.0979	-0.110**	0.152	0.0780
	(0.407)	(0.0712)	(0.0340)	(0.0392)	(0.0154)	(0.0708)	(0.0519)	(0.112)	(0.0883)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wave FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	7463	6399	10303	10303	10303	15033	14998	3721	3713
Mean of dep. var.	4.205	0.551	0.838	0.814	0.0366	0.439	0.294	0.632	0.625

Source: Data used is the MIS & MICS 4-wave repeated cross section (col 1-7) and the Afrobarometer survey (col 8-9); rural samples only.

Notes: The dependent variables in columns 1 and 2 are the years of completed education and literacy status for women 15-19 years of age. In columns 3-7, the dependent variables are dummies for whether the respondent received different types of antenatal care (ANC) while pregnant; IPTp refers to the administration of a dose of an antimalarial drug to a pregnant woman. For the outcomes in columns 8 and 9, the respondent is asked, "Over the past year, how often, if ever, have you or anyone in your family" ... "gone without enough food to eat" or "gone without medicines or medical treatment?" The dependent variable is equal to 1 if the response is *several times*, *many times*, or *always*, and equal to 0 if *never* or *just once or twice*. Robust standard errors in parentheses, adjusted for clustering at the district level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 6 – Wealth of vanilla producers and non-producers

	(1)	(2)	(3)
Panel A. Full Sample			
Vanilla commune × producer × post	0.664***	0.652***	0.658***
	(0.162)	(0.184)	(0.167)
Vanilla commune × non-producer × post	0.0272	0.0725	0.0190
	(0.190)	(0.198)	(0.191)
Vanilla producer	-0.352*	-0.398**	
	(0.203)	(0.177)	
N	3162	2893	3162
Mean of dep. var.	-0.0734	-0.0689	-0.0734
Panel C. Restrict to agricultural households			
Vanilla commune × producer × post	0.672***	0.649***	0.664***
	(0.160)	(0.184)	(0.165)
Vanilla commune × non-producer × post	0.178*	0.226**	0.181*
	(0.102)	(0.0983)	(0.102)
Vanilla producer	-0.189	-0.277**	
	(0.153)	(0.128)	
N	2491	2299	2491
Mean of dep. var.	-0.310	-0.294	-0.310
Controls	No	Yes	No
Wave FE	Yes	Yes	Yes
Zone FE	Yes	Yes	No
Household FE	No	No	Yes

Source: Data used is the DEMTREND cohort panel.
Notes: The dependent variable is the household asset index, standardized by the mean and standard deviation of the non-vanilla producing households in wave 3. "Vanilla Communes" refers to the communes where vanilla was listed as one of the top-5 crops in the 2007 commune census. The zone FEs include fixed effects for the zones from both wave 1 and wave 3. Robust standard errors in parentheses, adjusted for two-way clustering on community in wave 1 and community in wave 3. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

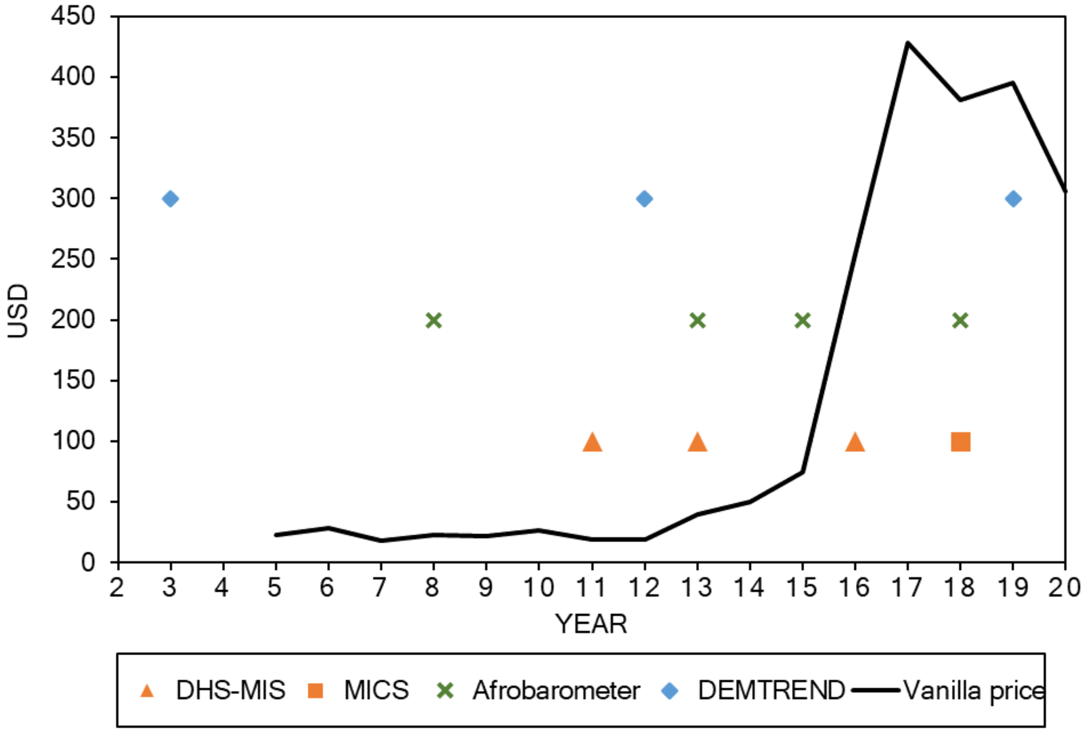
Online Appendix for:

The effects of a resource boom on wealth and human capital in Madagascar

A Data appendix

A.1 Summary of datasets

Figure A1 – Survey timing and vanilla price



Notes: Timing of survey data used for analysis. X-axis displays the year of the vanilla price and survey year. Y-axis displays the vanilla price from the COMTRADE database. Graph based on authors' calculations for the average value of a kilogram of vanilla exported from Madagascar at the annual level for 2005-2020 expressed in USD.

Table A1 – Dataset descriptions

Dataset	**DEMTREND**	**Afrobarometer**	**MIS-MICS**
Years collected	2003-04 2011-12 2019-20	2008 2013 2015 2018	2011 (MIS) 2013 (MIS) 2016 (MIS) 2018 (MICS)
Type	Panel	Repeated CS	Repeated CS/CS
Information on vanilla	Farmers 2019-20, Commune census	Commune census	Commune census
Sources of variation	Time, farmers, spatial (IV)	Time, spatial	Time, spatial
Outcomes	Wealth (asset index) Labor Unpaid work Emotional stability Cognitive tests Financial	Economic well-being	Wealth (asset index) Yrs education and literacy (women over 15) Antenatal care IPTp Child fever Bednets Anthropometry (2018 CS only) Birth certificate (2018 CS only)

Notes: Table displays datasets used for the study. CS refers to cross-section. Spatial variation refers to variation coming from the commune census. Time variation refers to variation coming from observing units before and after vanilla shock. IPTp refers to the receipt of intermittent preventive treatment of malaria (IPTp) drugs during pregnancy.

A.2 Data collection and variable construction details

A.2.1 DEMTREND sampling

The full panel is referred to as the DEMTREND panel in this paper. The individual survey wave in 2004 is referred to as the Progression through School and Academic Performance in Madagascar Survey (or EPSPAM) and the second and third individual waves collected in 2011/12 and 2019/20 are referred to as the Madagascar Life Course Transition of Young Adults surveys. The EPSPAM covered all regions in Madagascar, and its sample came from a primary school-based survey (PASEC). The data covers all areas of the country, but due to the school-based sampling was not designed to be strictly representative of all the households in Madagascar. The sampling cluster (community) in the EPSPAM survey was defined as the catchment area of a primary school, and the data was collected in 73 such clusters, including data on children in a total of 2,100 households (Glick et al., 2015).

Tracking and re-interviewing survey respondents in 2011/12 as well as 2019/20 involved, first, returning to the original clusters with names and contact information and basic characteristics on household members. Community leaders were a first point of contact to inquire about household members that were not located, in addition to speaking with other community members. If the household had moved within the same community or to a nearby location reachable to the survey team, it was visited in that new location. For located households, survey personnel asked about the residence of children in the cohort, who were now 21 to 24 years of age in 2011/12. Those still living in the same household or in a nearby location were interviewed in this phase. If not, contact information and location of the cohort members were obtained from their previous household. If the entire household had moved, the teams asked community leaders, neighbors, administrators and other community members about the location of the household, and of the location of the cohort member specifically, as these could differ. This information was used to plan and carry out the cohort member and in some cases, household interviews in new locations. These cohort members were either reached by other data collection teams working in another part of the country at the same time, or, reached later during subsequent visits within the same wave. Tracking procedures are also described in detail in Herrera Almanza et al. (2017).

A.2.2 Data and variable construction of asset index

MIS and MICS pooled cross-sections The wealth index variables used are those provided in the survey data. The wealth indices in both the MIS and the MICS surveys are calculated using Principal Component Analysis (PCA), which employs data on household's ownership of selected durable assets, materials used for housing construction; and types of water access and sanitation facilities. The methodology for the wealth index construction is explained in more detail in DHS (2016) for the MIS survey and in Unicef (2016) for the MICS surveys. For our analysis, the asset index is normalized so that the non-vanilla region has a mean of 0 and standard deviation of 1 in the post-period.

DEMTREND panel The asset index is constructed using factor analysis on durable asset ownership by the household. The assets ownership variables are indicator variables denoting whether the household owns any of the following assets: stove, fridge, freezer, charcoal oven, oven, sewing machine, radio, industrial oil lamp, artisanal oil lamp, record player, television, digital record player, camera, bicycle, motorbike, car, satellite antenna, iron, furniture, computer, and phone. The asset index is normalized relative to the mean and standard deviation of the non-producer group in the final wave.

A.2.3 Data and variable construction of emotional stability

In the DEMTREND data, we construct indices of emotional stability using 19 questions from the non-cognitive personality questionnaire administered to the DEMTREND cohort. Respondents were asked to rate their agreement (on a scale of 1 to 5) with questions such as "I am often worried" and "I fear the worst will happen". The full list of 19 questions is displayed in Appendix Table A2. We construct two indices: in column 1, the dependent variable consists of the average of the cohort member's responses across all 19 questions (on a scale of 1 to 5, and negating the sign on certain questions so that higher values indicating better scores); in column 2, the dependent variable is constructed using factor analysis on the 19 questions following the approach of Sahn and Villa (2016). We use as our dependent variable the individual's score on the Big 5 trait known as "neuroticism" or "emotional instability", but we negate the sign so that higher values correspond to lower levels of neuroticism and therefore higher levels of emotional *stability*. The DEMTREND module on non-cognitive traits contained a series of questions designed to measure the "Big 5" personality traits, including the 19 questions related to emotional stability. We interpret these estimates on emotional stability as proxies for the effects on the individual's psychological well-being, relying on previous research that has shown that emotional stability is highly correlated with measures of psychological well-being (DeNeve and Cooper, 1998; Hills and Argyle, 2001; Winzer et al., 2021).

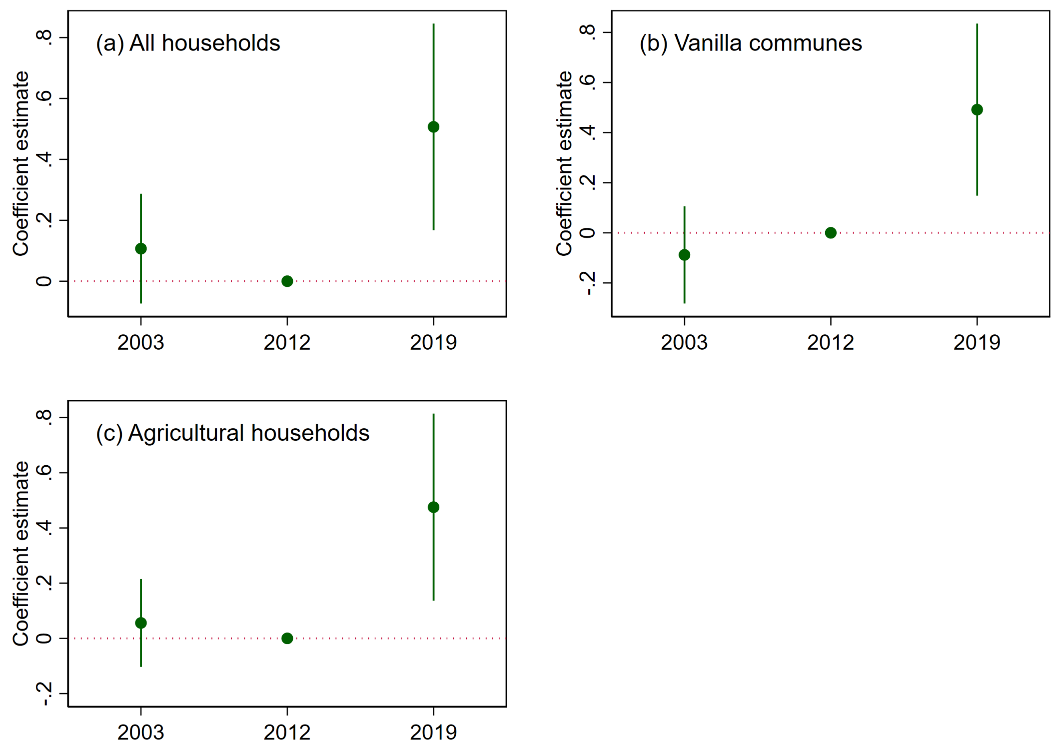
Table A2 – Questions in the emotional stability score: DEMTREND panel

1	I am often worried
2	I am not very anxious
3	I do not like myself
4	I am often sad
5	I am able to achieve my goals
6	I have a bad feeling about what is going to happen
7	I panic easily
8	I find all aspects of life problematic
9	I am easily overwhelmed
10	I have trouble expressing my feelings
11	It is difficult to describe my personality
12	I give up easily
13	I get discouraged easily
14	I feel like I am a bad person
15	I get easily frustrated
16	It is often difficult for me to have fun
17	I exaggerate my problems
18	I am afraid that the worst will happen
19	I am consumed by my own problems

Notes: The list of (English translations of) individual questions from the DEMTREND cohort panel used in the measures of psychological well-being in Table 4. The respondent gave numerical responses (from 1 to 5) to these 19 questions related to "emotional stability" embedded in a non-cognitive (Big Five) questionnaire containing a total of 92 questions. In Table 4 higher values indicate higher levels of "emotional stability" or, equivalently, lower levels of "neuroticism". Therefore, negative statements (questions on all rows except 2 and 5) were coded in reverse order so that a high number indicated higher "emotional stability" for each individual question.

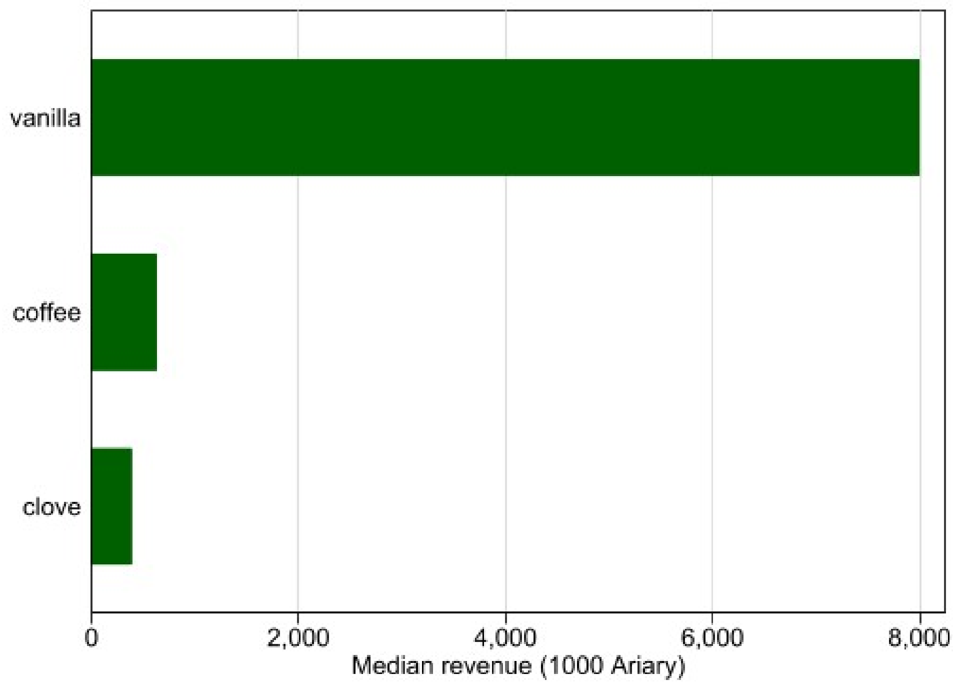
B Additional figures and tables

Figure B1 – Wealth of vanilla producers



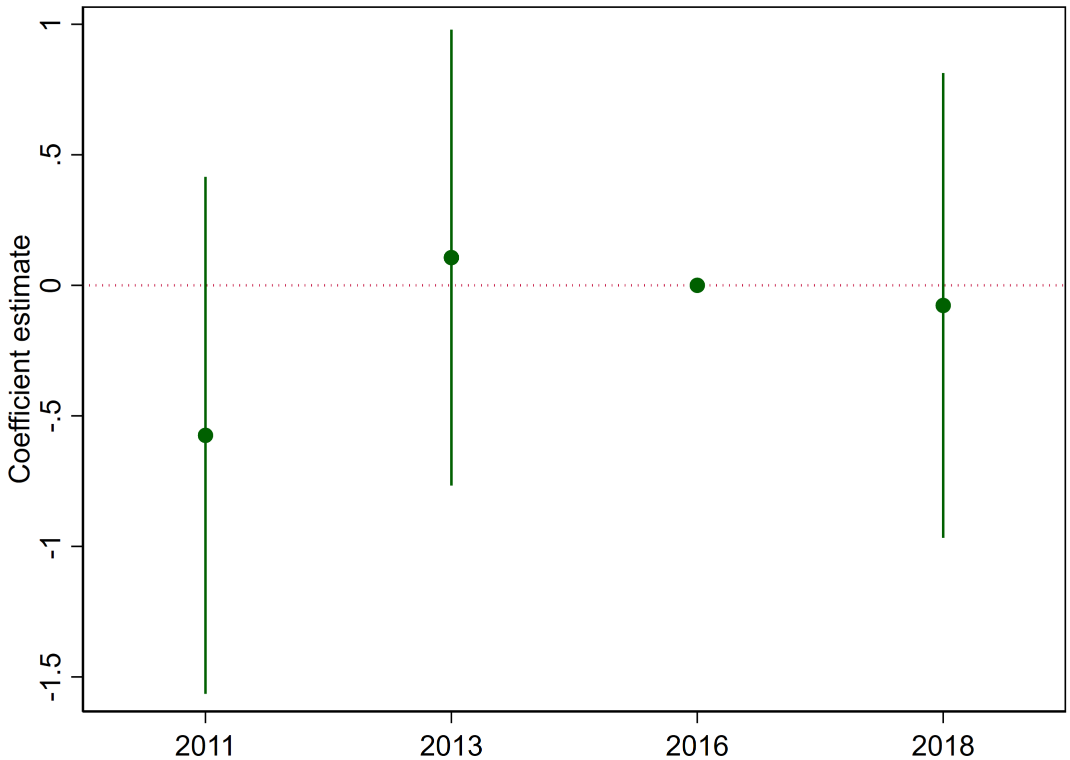
Notes: Data used is the 3-wave DEMTREND cohort panel for the years 2003, 2012, and 2019. The dependent variable is the household asset index. Each marker represents the point estimate and 95% confidence interval from the interaction between the vanilla-commune and survey-year indicators. The estimation samples correspond to those from Panels (a)-(c) in Table 1; see the notes to that table for additional details. Robust standard errors in parentheses, adjusted for clustering at the zone level. The p-values for significance tests of the pre-period coefficients are 0.24, 0.36, and 0.49, respectively.

Figure B2 – Median annual revenue of cash crop producers reported in 2019



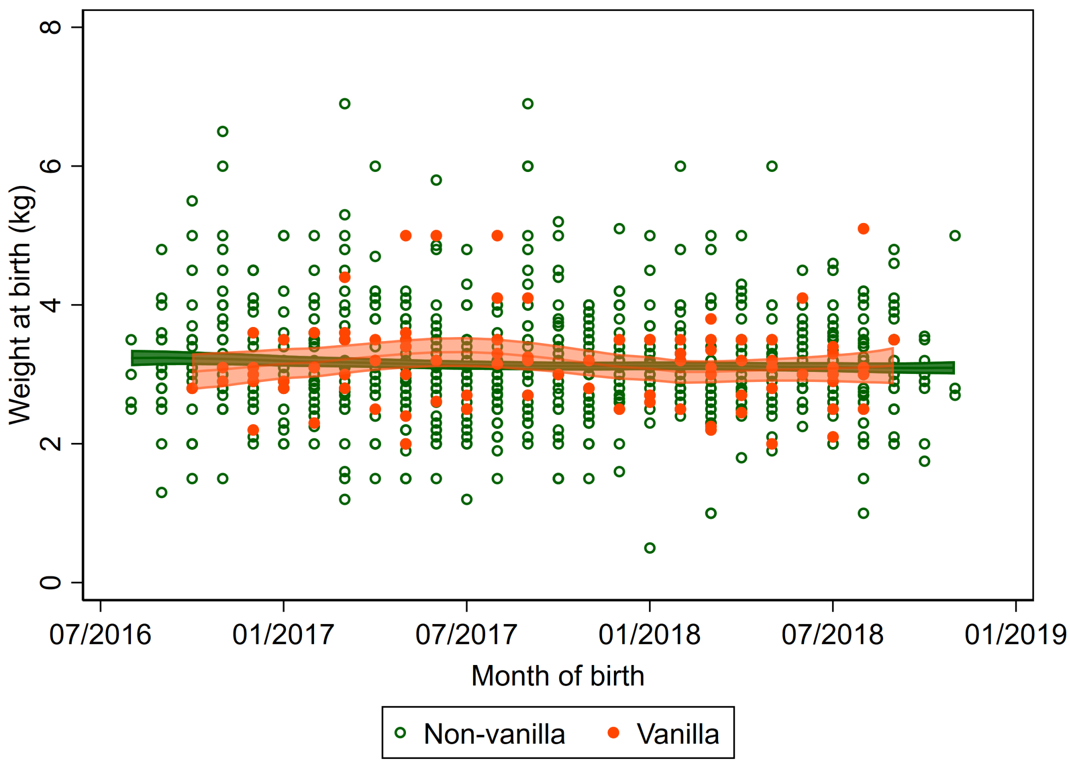
Notes: Data used is the DEMTREND dataset 2019 wave. Median revenue for each crop is calculated among the households producing that crop and expressed in 1000 Ariary. The median revenue of vanilla crop in the previous 12 months before the 2019 survey was 8,000,000 Ariary, which corresponds to USD 7,131.60 (in 2019 PPP).

Figure B3 – Girls' education in vanilla-growing regions



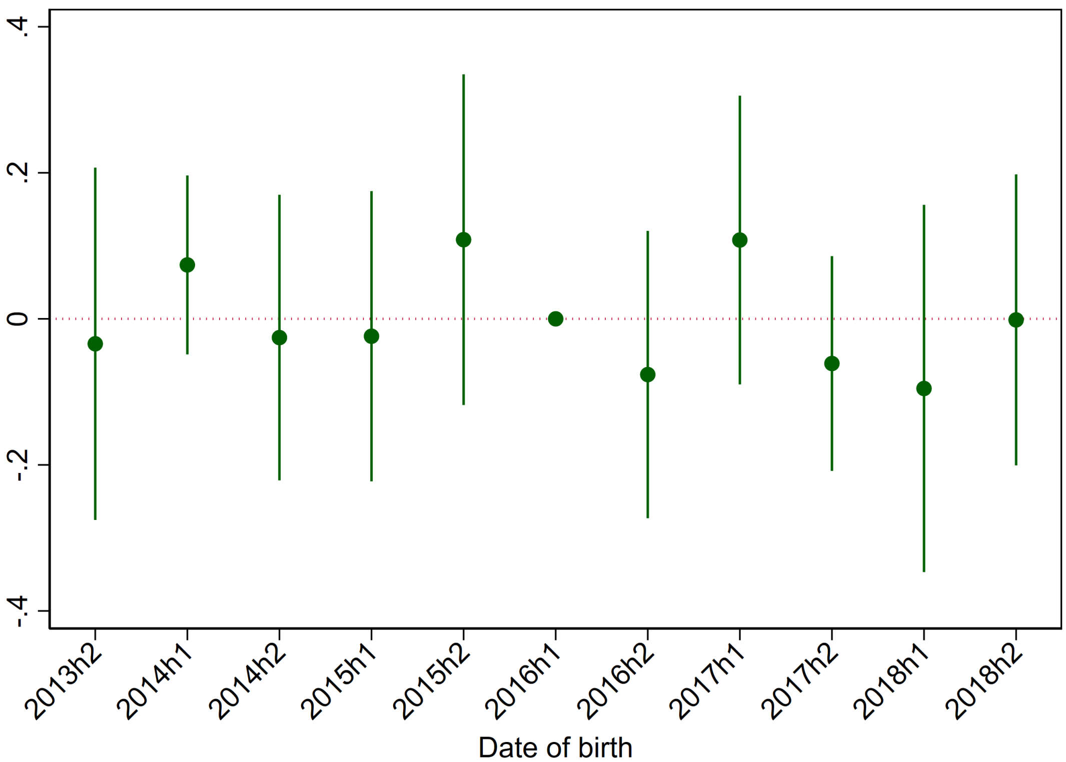
Notes: Data used is the MIS & MICS 4-wave repeated cross section; rural sample only; estimates are from an individual-level regression with district fixed effects. We regress years of education of women between 15-19 years of age on vanilla commune × survey year fixed effects, district × vanilla commune fixed effects, age × survey year fixed effects, and a set of religion dummies. Each marker represents the point estimate from vanilla commune × survey year fixed effect, except year 2016, which is the reference year. The figure displays the point estimate and 95% confidence interval. Population weights are used in the regression. Standard errors are adjusted for clustering at the district level.

Figure B4 – Cross-sectional comparisons of birth weight in vanilla-growing and non-vanilla-growing regions



Notes: Data used is the MICS 2018 survey; rural sample only. The figure plots birth weight by month of birth for children born in the 2 years before the survey, separately for vanilla and non-vanilla communes. Since this question is only asked about children born in the last 2 years, the data set only includes information on children born in the 'post' period (after vanilla prices had already begun to increase). The lines display a local polynomial smooth with 95% confidence intervals.

Figure B5 – Retrospective panel: Child birth certificate status by date of birth



Notes: Data used is the MICS 2018 survey; rural sample only. The figure plots the coefficient estimates from the interaction between indicator variables representing the timing of birth and an indicator for whether the child resides in a vanilla-growing commune. Births are grouped into 6-month (i.e., half-year) increments. The outcome variable is an indicator for whether the child has a birth certificate. Estimates are relative to the base period of 2016h1 (the first 6 months of 2016).

Table B1 – Summary statistics by wave: DEMTREND panel

	All years	2003		2012		2019	
	Pooled	Non-Vanilla	Vanilla	Non-Vanilla	Vanilla	Non-Vanilla	Vanilla
Asset index	.019	.063	-.25	.071	-.35	-1.7e-09	.09
Formal savings	.18	.063	.079	.13	.17	.42	.4
Informal savings	.21	.14	.079	.33	.83	.12	.7
Loan	.14	.073	.032	.29	.42	.041	.016
Received remittances	.14	.098	.079	.22	.25	.11	.016
Sent remittances	.22	.	.	.28	.17	.15	0
Phone	.52	.	.	.5	.27	.57	.68
Motorcycle	.047	.0093	.016	.051	.017	.088	.32
Bicycle	.3	.31	.33	.32	.35	.29	.3
Television	.24	.16	.032	.3	.15	.34	.37
Radio	.59	.5	.38	.64	.87	.7	.78
Fridge freezer	.045	.033	0	.052	.017	.068	.016
Currently working	.83	.	.	.77	.86	.89	.9
Worked in the last 7 days	.76	.	.	.69	.83	.82	.75
Worked in the last 12 months	.84	.	.	.78	.86	.9	.92
Total hours spent in employment in the last 12 months	1078	.	.	859	673	1332	1299
Has an agriculture/livestock occupation	.59	.	.	.67	.92	.48	.97
Number of hours spent in the last 12 months doing agriculture	509	.	.	507	596	459	1183
Minutes per day devoted to all six unpaid work	196	.	.	210	191	165	93
French score	.49	.	.	.46	.34	.56	.47
Math score	.41	.	.	.42	.31	.42	.38
Emotional stability (average)	3.6	.	.	3.7	3.5	3.5	3.5
Emotional stability (factor analysis)	.14	.	.	.26	-.0077	-2.9e-09	.058
New Household	.36	0	0	.49	.43	.62	.71
Household size	5.2	6.9	6.7	5	5	3.7	3.1
Female household head 2012	.16	.16	.13	.16	.13	.16	.13
Highest grade in 2012	7.7	7.9	7.2	7.9	7.2	7.9	7.2
Height in 2012	160	160	160	160	160	160	160
Observations	5645	1391	63	1281	60	1391	63

Notes: Table displays means of selected variables from the DEMTREND cohort panel dataset, which consists of 3 waves (2003, 2012, and 2019). Statistics are displayed separately for vanilla-producing and non-vanilla-producing households.

Table B2 – Summary statistics by sample: DEMTREND panel

	Full sample		Vanilla communes		Agricultural households	
	Non-Vanilla	Vanilla	Non-Vanilla	Vanilla	Non-Vanilla	Vanilla
Asset index	.045	-.17	-.09	-.17	-.19	-.17
Formal savings	.21	.22	.21	.22	.18	.22
Informal savings	.2	.53	.23	.53	.19	.53
Loan	.13	.15	.15	.15	.12	.15
Received remittances	.14	.11	.097	.11	.12	.11
Sent remittances	.21	.081	.13	.081	.2	.081
Phone	.53	.48	.39	.48	.45	.48
Motorcycle	.048	.12	.055	.12	.035	.12
Bicycle	.3	.33	.29	.33	.3	.33
Television	.26	.18	.21	.18	.17	.18
Radio	.61	.67	.51	.67	.59	.67
Fridge freezer	.05	.011	.051	.011	.024	.011
Currently working	.83	.89	.85	.89	.88	.89
Worked in the last 7 days	.76	.79	.79	.79	.81	.79
Worked in the last 12 months	.84	.89	.86	.89	.89	.89
Total hours spent in employment in the last 12 months	1107	994	1036	994	1127	994
Has an agriculture/livestock occupation	.56	.94	.67	.94	.69	.94
Number of hours spent in the last 12 months doing agriculture	482	897	519	897	622	897
Minutes per day devoted to all six unpaid work	187	141	173	141	191	141
French score	.51	.4	.47	.4	.46	.4
Math score	.42	.35	.38	.35	.38	.35
Emotional stability (average)	3.6	3.5	3.5	3.5	3.6	3.5
Emotional stability (factor analysis)	.13	.024	.046	.024	.09	.024
New Household	.38	.39	.4	.39	.36	.39
Household size	5.1	4.9	4.7	4.9	5.3	4.9
Female household head 2012	.16	.13	.22	.13	.14	.13
Highest grade in 2012	7.9	7.2	7.5	7.2	7.3	7.2
Height in 2012	160	160	160	160	159	160
Observations	4063	186	693	186	3092	186

Notes: Table displays means of selected variables from the DEMTREND cohort panel dataset with the three samples used for the analysis: full sample, sample restricted to vanilla communities, and sample restricted to agricultural households. Statistics are displayed as pooled across the three waves (2003, 2012, and 2019).

Table B3 – Summary statistics by wave: MIS and MICS rural sample

	All years	2011		2013		2016		2018	
	Pooled rural	Non-Vanilla	Vanilla	Non-Vanilla	Vanilla	Non-Vanilla	Vanilla	Non-Vanilla	Vanilla
wealth_idx_std_fullsample	-.25	-.28	-.24	-.29	-.35	-.18	-.28	-.28	.034
Mobile phone	.32	.23	.13	.23	.19	.3	.27	.41	.53
Motorcycle	.025	.017	.006	.023	.0092	.03	.036	.02	.093
Car	.01	.016	.006	.017	.0023	.0091	.004	.0066	.0075
Radio	.46	.48	.61	.47	.45	.48	.52	.41	.54
Bicycle	.18	.2	.16	.19	.17	.18	.13	.17	.11
Watch	.26	.35	.26	.3	.22	.31	.24	.19	.22
Bank Account	.041	.062	.056	.045	.034	.048	.035	.026	.03
Finished Roof	.26	.25	.37	.28	.4	.26	.35	.22	.48
Protected water source	.32	.32	.25	.33	.27	.41	.17	.29	.27
Piped water	.13	.14	.11	.11	.13	.18	.067	.11	.14
Toilet with any Facility	.46	.36	.58	.37	.48	.56	.67	.47	.55
Age of the mother	28	28	29	29	28	28	28	28	28
Religion: Catholic	.3	.28	.23	.31	.37	.32	.24	.29	.3
Religion: Protestant	.31	.33	.42	.32	.25	.33	.25	.29	.27
Religion: NO	.21	.36	.24	.29	.3	.26	.43	.057	.084
Religion: Others	.19	.034	.11	.069	.081	.093	.089	.37	.34
Number of births	2.9	3.2	3.2	3.1	2.1	2.8	2.7	2.8	2.2
Living in rural area	1	1	1	1	1	1	1	1	1
Household head illiterate	.34	.38	.3	.37	.22	.32	.35	.34	.27
Observations	33704	5559	337	5323	444	7633	1008	12058	1207

Notes: MIS & MICS 4-wave repeated cross section has 3 waves of DHS-MIS data from years 2011, 2013, and 2016, and MICS data from 2018. The sample here is restricted to rural enumeration areas only. Means are displayed separately for vanilla communes and non-vanilla communes.

Table B4 – Summary statistics by wave: Afrobarometer rural sample

	All years	2008		2013		2014		2018	
	Pooled	Non-Vanilla	Vanilla	Non-Vanilla	Vanilla	Non-Vanilla	Vanilla	Non-Vanilla	Vanilla
Female	.5	.5	.5	.5	.5	.5	.5	.5	.5
Own living conditions	.46	.58	.53	.44	.38	.35	.39	.44	.75
Country economic conditions	.41	.67	.63	.33	.3	.3	.35	.28	.69
Country econ conditions vs. 12 mos. ago	.53	.71	.59	.52	.54	.5	.46	.37	.73
Country econ conditions in 12 months	.68	.83	.65	.75	.76	.64	.58	.56	.76
Often without food	.62	.59	.54	.65	.62	.63	.62	.63	.64
Often without water	.52	.36	.4	.57	.5	.64	.84	.51	.6
Often without medical care	.55	.54	.65	.51	.55	.49	.63	.62	.74
Often without cooking fuel	.28	.29	.32	.33	.14	.25	.29	.28	.26
Often without cash	.85	.8	.83	.85	.92	.84	.91	.9	.85
Piped water in enumeration area	.3	.23	.17	.36	.2	.36	.15	.31	.27
Sewage system in enumeration area	.028	.032	0	.021	0	.038	0	.038	0
Car or motorcycle	.043	.034	.028	.02	.017	.064	.058	.057	.024
Television	.14	.17	.13	.092	.017	.18	.13	.14	.19
Radio	.68	.71	.73	.64	.56	.73	.65	.62	.81
Mobile phone	.43	.	.	.	.	.41	.38	.44	.61
Observations	3806	888	106	760	120	840	104	832	88

Notes: Afrobarometer data used has 4 waves in 2008, 2013, 2014 and 2018. We restrict the data to rural enumeration areas. The variables "Own living conditions not bad?" and "Country economic conditions not bad?" equal 1 for respondents who answered *very good*, *fairly good*, or *neither good nor bad*, as opposed to *fairly bad* or *very bad*. "Country economic conditions vs. 12 mo ago?" an ".. in 12 mo time?"are indicators equaling 1 if the respondent answered *same*, *better*, or *much better*. The questions starting with "Often without ..." the respondent is asked, "Over the past year, how often, if ever, have you or anyone in your family gone without" each of the indicated necessities. The dependent variable is equal to 1 if the response is *several times*, *many times*, or *always*, and equal to 0 if *never* or *just once or twice*. Questions on assets and public infrastructure are all binary outcomes.

Table B5 – Financial outcomes of vanilla producers

	Formal savings	Informal savings	Loans	Received remittances	Sent remittances
	(1)	(2)	(3)	(4)	(5)
Panel A. Full Sample					
Vanilla producer × post	-0.0487	0.372***	-0.0662	-0.103***	-0.0373
	(0.139)	(0.0813)	(0.0915)	(0.0330)	(0.0471)
N	4224	4224	4224	4224	2640
R-Squared	0.478	0.427	0.435	0.398	0.572
Panel B. Restrict to vanilla communes					
Vanilla producer × post	-0.0848	0.285***	-0.00108	-0.109***	-0.0845
	(0.142)	(0.0829)	(0.0910)	(0.0369)	(0.0590)
N	877	877	877	877	558
R-Squared	0.451	0.508	0.524	0.405	0.574
Panel C. Restrict to agricultural households					
Vanilla producer × post	-0.0574	0.384***	-0.0761	-0.116***	-0.0415
	(0.138)	(0.0816)	(0.0912)	(0.0340)	(0.0488)
N	3269	3269	3269	3269	2086
R-Squared	0.474	0.440	0.427	0.368	0.573
Panel D. IV, restrict to agricultural households					
Vanilla producer × post	-0.284	0.760***	-0.275	-0.174***	-0.0353
	(0.245)	(0.131)	(0.187)	(0.0526)	(0.0950)
N	2520	2520	2520	2520	1620
R-Squared	-0.007	-0.000	-0.008	0.003	0.000
First stage F stat	21.9	21.9	21.9	21.9	21.3
Wave FE	Yes	Yes	Yes	Yes	Yes
Household FEs	Yes	Yes	Yes	Yes	Yes

Notes: Data used is the DEMTREND cohort panel. The dependent variables are indicators defined as follows: "Formal savings" indicates the household has an account with any type of bank, life insurance company, or a micro finance institution; "Informal savings" indicates savings in an informal institution, an association, or at home; "Loans" indicates whether the household has a loan that they have not paid back in full from any kind of bank, friends, neighbors, family members, business partners or employers informal credit associations or anywhere else, excluding in-kind loans; "Received remittances" indicates whether the household or any of its members has received money or goods from individuals outside the household in the last 12 months; and "Sent remittances" indicates whether the household or any of its members have made a similar transfer to someone outside of the household. Robust standard errors in parentheses, adjusted for clustering at the zone level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B6 – Wealth in vanilla-producing regions

	Full sample		Rural		Urban	
	(1)	(2)	(3)	(4)	(5)	(6)
Vanilla commune × post	0.370***	0.344***	0.293***	0.277***	0.467	0.396
	(0.104)	(0.0609)	(0.0729)	(0.0606)	(0.298)	(0.251)
Controls	No	Yes	No	Yes	No	Yes
Wave FE	Yes	Yes	Yes	Yes	Yes	Yes
District × vanilla FE	Yes	Yes	Yes	Yes	Yes	Yes
N	43040	43040	32465	32465	10575	10575
Mean of dep. var.	-3.86e-10	-3.86e-10	-0.284	-0.284	0.798	0.798

Notes: Data used is the MIS & MICS 4-wave repeated cross section; includes rural and urban households. The dependent variable is the household asset index. "Vanilla commune" indicates that vanilla was reported as one of the top 5 crops in the commune census, and "Post" is an indicator for the fourth round of data in 2018. Controls include the age of the respondent, dummies for catholic, protestant, and no religion, number of births given by the mother, a dummy indicating whether the household resides in a rural community, and a dummy for household head being illiterate. Population weights are used in each regression. Robust standard errors in parentheses, adjusted for clustering at the district level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B7 – Perceptions of economic well-being in vanilla-producing regions

		Economic conditions in the country		
	(1) Own living conditions	(2) Current	(3) Compared to 12 months ago	(4) In 12 months
Vanilla commune × post	0.274***	0.419**	0.395***	0.339***
	(0.104)	(0.163)	(0.117)	(0.0891)
Controls	Yes	Yes	Yes	Yes
Wave FE	Yes	Yes	Yes	Yes
District × vanilla FE	Yes	Yes	Yes	Yes
Mean of dep. var.	0.439	0.281	0.373	0.563
Observations	3715	3560	3563	3087

Source: Data used is the Afrobarometer survey; rural sample only.
Notes: See notes to Figure 4 for descriptions of dependent variables. "Vanilla commune" indicates that vanilla was reported as one of the top 5 crops in the commune census, and "Post" is an indicator for the fourth round of data in 2018. Control variables include dummies for age categories and gender of the respondent. Population weights are used in the regressions. Robust standard errors in parentheses, adjusted for clustering at the district level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B8 – Wealth of vanilla producers: additional specifications using commune-level spatial variation

	(1)	(2)	(3)
Panel 1. Reduced form, restrict to agricultural households			
Vanilla commune × post	0.340**	0.345**	0.352**
	(0.167)	(0.165)	(0.167)
N	2947	2716	2943
R-Squared	0.293	0.329	0.582
Panel 2. Reduced form, full sample			
Vanilla commune × post	0.215	0.237	0.216
	(0.215)	(0.215)	(0.218)
N	3741	3408	3732
R-Squared	0.347	0.382	0.623
Panel 3. IV, full sample			
Vanilla producer × post	0.727*	0.777**	0.709*
	(0.370)	(0.365)	(0.378)
N	3191	2920	3191
R-Squared	0.004	0.058	0.007
First stage F stat	11.1	11.2	11.1
Controls	No	Yes	No
Zone FEs	Yes	Yes	No
Wave FE	Yes	Yes	Yes
Household FEs	No	No	Yes

Notes: Data used is the DEMTREND cohort panel. Panel 1 presents the reduced form of the IV results displayed in Table 1 Panel D using the sample of agricultural households only. Panel 2 and Panel 3 display results of the reduced form and the second stage of an IV analysis, respectively, using the full sample. The dependent variable is the household asset index, standardized by the mean and standard deviation of the non-vanilla producing households in wave 3. "Vanilla commune" here is an indicator for communes where vanilla was listed as one of the top-5 crops in the 2007 commune census. The IV specification in panel 3 instruments "vanilla producer" with the "vanilla commune" indicator. Control variables include household size, whether the household is new, female household head (in 2012), highest grade attained by the cohort member in 2012, and the cohort members height in 2012 in centimeters. Robust standard errors in parentheses, adjusted for clustering at the zone level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B9 – Assets of vanilla producers

	Mobile phone	Motorcycle	Bicycle	Television	Radio	Fridge freezer
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Full Sample						
Vanilla producer × post	0.336***	0.246**	-0.0124	0.162**	0.0370	-0.0154
	(0.0675)	(0.108)	(0.115)	(0.0800)	(0.0645)	(0.0180)
N	2438	4099	4099	4099	4099	4099
R-Squared	0.684	0.457	0.418	0.637	0.436	0.526
Panel B. Restrict to vanilla communes						
Vanilla producer × post	0.244***	0.239**	0.0143	0.204***	-0.0546	0.00254
	(0.0654)	(0.103)	(0.130)	(0.0746)	(0.0587)	(0.0227)
N	548	872	872	872	872	872
R-Squared	0.700	0.509	0.408	0.615	0.471	0.516
Panel C. Restrict to agricultural households						
Vanilla producer × post	0.314***	0.261**	-0.0427	0.179**	0.0381	-0.0125
	(0.0693)	(0.109)	(0.116)	(0.0800)	(0.0656)	(0.0176)
N	1930	3179	3179	3179	3179	3179
R-Squared	0.661	0.446	0.432	0.598	0.430	0.460
Panel D. IV, restrict to agricultural households						
Vanilla producer × post	0.613***	0.445***	-0.0350	0.327***	0.159	0.0383
	(0.121)	(0.113)	(0.214)	(0.0984)	(0.200)	(0.0441)
N	1620	2520	2520	2520	2520	2520
R-Squared	0.005	0.022	0.000	0.008	-0.002	-0.003
First stage F stat	21.3	21.9	21.9	21.9	21.9	21.9
Wave FE	Yes	Yes	Yes	Yes	Yes	Yes
Household FEs	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Data used is the DEMTREND cohort panel. The dependent variables are indicators for the ownership of each individual durable asset. Household fixed effects are used in each specification. "Vanilla producer" indicates that household produced vanilla during wave 3 of the household survey in 2019. "Post" takes value one for the 2019 wave. Wave FEs include dummies for years 2003, 2012 and 2019. Data on mobile phones (col 1) are only available for waves 2 and 3. Robust standard errors in parentheses, adjusted for clustering at the zone level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B10 – Specific assets in vanilla-producing regions

(a) MIS-MICS sample

	(1) Car	(2) Watch	(3) Bank Account	(4) Finished Roof
Vanilla commune × post	0.00540	0.117***	-0.000672	0.0964***
	(0.00547)	(0.0387)	(0.0143)	(0.0279)
Controls	Yes	Yes	Yes	Yes
Wave FE	Yes	Yes	Yes	Yes
District × vanilla FE	Yes	Yes	Yes	Yes
N	32268	32377	32464	32271
Mean of dep. var.	0.00562	0.185	0.0251	0.221

(b) Afrobarometer sample

	(1) Mobile Phone†	(2) Car or Motorcycle	(3) Radio	(4) Television
Vanilla commune × post	0.155	-0.0347	0.294***	0.0858
	(0.103)	(0.0318)	(0.106)	(0.0708)
Controls	Yes	Yes	Yes	Yes
Wave FE	Yes	Yes	Yes	Yes
District × vanilla FE	Yes	Yes	Yes	Yes
Mean of dep. var.	0.444	0.0570	0.622	0.140
N	1859	3694	3716	3697

Notes: Panel (a) displays results using the MIS & MICS 4-wave repeated cross section, while panel (b) uses the Afrobarometer survey; rural samples only. The dependent variables are indicators for whether the household (or a member of the household) owns that particular asset. †Data on mobile phone ownership in the Afrobarometer survey is only available for the final 2 rounds (in 2015 and 2018). Robust standard errors in parentheses, adjusted for clustering at the district level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B11 – Child anthropometry in vanilla-producing regions: younger vs. older children

	(1) Height for age	(2) Weight for age	(3) Weight for height	(4) Stunting	(5) Underweight	(6) Wasting
Vanilla commune × under 24 months	0.0702	0.00115	-0.0374	-0.0509	0.0257	0.0242
	(0.130)	(0.118)	(0.112)	(0.0464)	(0.0354)	(0.0202)
Controls	No	No	No	No	No	No
District × vanilla FE	Yes	Yes	Yes	Yes	Yes	Yes
N	9581	9581	9581	9581	9581	9581

Notes: Data used is the MICS 2018 rural sample; children under 5 years old. The table reports the coefficient from a difference-in-differences regression comparing children 0-23 months old to older children 24-59 months old, for children residing in vanilla versus non-vanilla communes. Population weights are used in each regression. Robust standard errors in parentheses, adjusted for clustering at the district level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B12 – Child fever and household bednets in vanilla-producing regions

	Child Fever and Medical Care			Slept under bednet		Number of bednets	
	(1) Fever symptoms	(2) Care (conditional)	(3) Care (uncond.)	(4) Children	(5) Pregnant Women	(6) per 2 people	(7) per person
Vanilla commune × post	-0.0376	0.00503	-0.0132	-0.0609*	-0.0866*	-0.0756	-0.150***
	(0.0259)	(0.0688)	(0.0114)	(0.0338)	(0.0454)	(0.0658)	(0.0403)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wave FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District × vanilla FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	24592	3778	24592	23653	2680	31107	31107
Mean of dep. var.	0.168	0.383	0.0644	0.664	0.685	0.749	0.474

Notes: Data used is the MIS & MICS 4-wave repeated cross section; rural sample only. The dependent variables are whether the child under 5 years of age had fever in the last 2 weeks; whether the child received medical care for fever, conditional on having symptoms (col 2) and for all children (col 3); whether the children and pregnant women of the household slept under a bednet the previous night; and the number of bednets per 2 people and per person in the household. "Vanilla commune" indicates that vanilla was reported as one of the top 5 crops in the commune census. "Post" takes value one for the fourth round of the data 2018. Wave FEs include dummies for years 2011, 2013 and 2018. Population weights are used in each regression. Robust standard errors in parentheses, adjusted for clustering at the district level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B13 – Cross-sectional results: Adult investment in children in vanilla-producing regions

	(1)	(2)	(3)
Children under 5 years of age			
1. Exclusively breastfed during first 6 months (0-23 mo)	0.0468*	0.0272	0.0536**
	(0.0245)	(0.0212)	(0.0239)
2. Predominantly breastfed during first 6 months (0-23 mo)	0.0565**	0.0300	0.0641**
	(0.0266)	(0.0219)	(0.0274)
3. Early stimulation and responsive care (24-59 mo)	0.122***	0.113***	0.101**
	(0.0377)	(0.0362)	(0.0407)
4. Preprimary education (36-59 mo)	0.0269	0.0225	-0.00329
	(0.0380)	(0.0362)	(0.0272)
5. Inadequate supervision (under 5 yrs)	-0.0175	-0.00727	-0.0105
	(0.0278)	(0.0267)	(0.0279)
6. Physical punishment (1-4 yrs)	-0.00606	-0.00729	-0.0110
	(0.0250)	(0.0246)	(0.0332)
7. Psychological aggression (1-4 yrs)	-0.0485**	-0.0446*	-0.0401
	(0.0243)	(0.0237)	(0.0299)
Children ages 5-14			
8. Physical punishment (5-14 yrs)	0.0184	0.0202	0.0165
	(0.0329)	(0.0325)	(0.0341)
9. Psychological aggression (5-14 yrs)	-0.0197	-0.0140	-0.0141
	(0.0219)	(0.0216)	(0.0240)
10. Child reads or is read to at home (7-14 yrs)	0.0940***	0.0856**	0.0976**
	(0.0349)	(0.0332)	(0.0387)
11. Child receives help with homework (7-14 yrs)	-0.00873	0.0174	0.0233
	(0.0537)	(0.0507)	(0.0550)
12. Caretaker received report card (7-14 yrs)	0.00177	0.0107	0.00401
	(0.0434)	(0.0401)	(0.0375)
13. Caretaker attended any school meeting or event (7-14 yrs)	-0.0518	-0.0445	-0.0304
	(0.0430)	(0.0428)	(0.0508)
Individual & HH controls		Y	Y
Mother-level controls			Y

Notes: Data used is the MICS 2018 rural sample. Each cell of the table corresponds to a separate regression and contains the estimated coefficient for the "Vanilla commune" variable (an indicator for whether vanilla was reported as one of the top 5 crops in the commune census). The dependent variable is reported in each row. Population weights are used in each regression. Robust standard errors in parentheses, adjusted for clustering at the commune level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B14 – Adult investment in children (cont.): # of observations for specifications in previous table

	(1)	(2)	(3)
Children under 5 years of age			
1. Exclusively breastfed during first 6 months (0-23 mo)	3872	3858	2732
2. Predominantly breastfed during first 6 months (0-23 mo)	3872	3858	2732
3. Early stimulation and responsive care (24-59 mo)	5646	5624	4105
4. Preprimary education (36-59 mo)	3801	3786	2752
5. Inadequate supervision (under 5 yrs)	9550	9514	6865
6. Physical punishment (1-4 yrs)	7604	7575	5529
7. Psychological aggression (1-4 yrs)	7606	7577	5531
Children ages 5-14			
8. Physical punishment (5-14 yrs)	7230	7199	5362
9. Psychological aggression (5-14 yrs)	7230	7199	5362
10. Child reads or is read to at home (7-14 yrs)	4717	4696	3384
11. Child receives help with homework (7-14 yrs)	2276	2266	1669
12. Caretaker received report card (7-14 yrs)	3526	3511	2591
13. Caretaker attended any school meeting or event (7-14 yrs)	3526	3511	2591
Individual & HH controls		Y	Y
Mother-level controls			Y

Notes: Data used is the MICS 2018 rural sample. Each row refers back to the previous table and displays the number of observations in each regression.

Table B15 – Household infrastructure in vanilla-producing regions

	(1) Protected water	(2) Toilet facility
Vanilla commune × post	0.102	-0.0230
	(0.0731)	(0.0302)
Mean of dep. var.	0.294	0.471
District × vanilla FEs	Yes	Yes
Controls	Yes	Yes
Wave FEs	Yes	Yes
Observations	32271	32271

Notes: Data used is the MIS & MICS 4-wave repeated cross section; rural sample only. The dependent variables are indicators for whether the household has access to a protected water source or a toilet facility. "Protected water" equals 1 if the household's water source is piped water (into dwelling, yard/plot, to neighbor, public tab or standpipe), protected well, or protected spring; "Toilet facility" indicates access to flush toilets, pit latrines, or composting toilets. Robust standard errors in parentheses, adjusted for clustering at the district level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B16 – Lack of basic necessities in vanilla-producing regions

	Often gone without enough...?		
	(1) Clean water	(2) Fuel for cooking	(3) Cash income
Vanilla commune × post	-0.0266	-0.0176	-0.0701
	(0.134)	(0.0837)	(0.0792)
Mean of dep. var.	0.514	0.285	0.903
District × vanilla FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes
Wave FE	Yes	Yes	Yes
Observations	3718	3719	3719

Notes: Data used is the Afrobarometer survey; rural sample only. The respondent is asked, "Over the past year, how often, if ever, have you or anyone in your family gone without" each of the indicated necessities. The dependent variable is equal to 1 if the response is *several times*, *many times*, or *always*, and equal to 0 if *never* or *just once or twice*. Robust standard errors in parentheses, adjusted for clustering at the district level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

C Robustness checks and alternative specifications

C.1 Alternative specifications

First, we estimate alternative specifications for the MIS-MICS dataset to account for the timing of the 2016 MIS, which was carried out during the initial stages of the price increase. In the difference-in-differences specification in Table 2, we included the 2016 wave as part of the pre-treatment period, under the assumption that some time lag is expected before producers would be fully affected by the price change. Here we discuss the results of several alternative specifications. First, in place of the "post" indicator, we instead interact our indicator for vanilla communes with the global vanilla price during the time of each survey.[1] This specification is meant to account for the fact that prices had already begun to rise in 2016, but would continue to rise even further by 2018. The results are presented in Table C1, and are generally consistent with the results from our main specification.

Next, we investigate a model where instead of creating a "post" indicator that is equal to one for the 2018 wave, we interact each wave indicator with the vanilla variable keeping the 2013 wave as the reference wave to understand whether the price increase affected producers already in 2016, or later in 2018, to justify the choice of our "post" indicator in our main specification using this dataset. These results are presented in Table C2. We can see that indeed the wealth increase is not statistically significant in 2016 (relative to the new base year of 2013), while it is in 2018. Finally, we estimate a specification where we simply exclude data from 2016; these results are shown in Table C3. We find that the results remain robust to excluding this period at the start of the price increase.

Our panel consists of cohort members who were living in the households of their childhood when first interviewed as teenagers in 2003. The majority of them have formed their own households either before 2012 or before 2019. We run a series of checks to determine whether our household wealth results are affected by changes in household status. These results are displayed in Table C6. We find that controlling for changing household status has almost no effect on our estimates. We also examine the impacts separately for people who change households and people who do not; this can shed light on whether the wealth effects are

[1] The data used is displayed in Figure 1b using data from the COMTRADE database.

driven by people moving into vanilla households between wave 2 (2012) and wave 3 (2019). If anything, we find that the estimates are larger for people who do not move between these waves. Vanilla producers who have already formed new households by 2012 (and are thus less likely to move again in response to the shock) see somewhat larger increases in wealth that people who remain in their original households, though the differences are not statistically significant (column 4 of Table C6). Likewise, vanilla producers who do not change households between waves 2 and 3 experience greater increases in household wealth relative to people moving into households that subsequently report vanilla production (column 5 of Table C6). Taken together these findings indicate that selection arising from changes in household formation is unlikely to be driving our household-level results.

C.2 Accounting for cyclone exposure

Vanilla farmers face uncertainties because of environmental and climatic factors that can adversely affect the vanilla harvest. On March 7, 2017, the Enawo cyclone hit the Northern coast of Madagascar with maximum sustained winds at 205 km/h (125 mph). Enawo made landfall over the vanilla-producing Sava region (between Antalaha and Sambava), representing the strongest cyclone to hit the country since 2004. The cyclone started to rapidly weaken as it moved inland, but caused major damage to infrastructure along the coast.

Given the expectation that exposure to the cyclone may have altered household financial decisions and choices regarding human capital investments, we run alternative specifications accounting for being exposed to Enawo. This is defined by residing in a location exposed to tropical cyclone force winds. The data for the cyclone track was obtained from the IBTrACS project.[2] Exposure was then modeled using the parametric wind speed model by Willoughby et al. (2006).[3] The optimal information for assessing the severity of the cyclone is the precise geolocation of the track of the cyclone with the highest wind speed.

[2]The IBTrACS Project, developed by the National Oceanic and Atmospheric Administration (NOAA) National Climate Data Center (NCDC), compiles best track data from forecast centers around the world to create a global dataset of 97 tropical cyclone locations and intensities (Knapp et al., 2010).

[3]The Willoughby et al. (2006) model is implemented using an adaptation of the software *stormwindmodel* in R following Tennant and Gilmore (2020). The model allows us to translate the storm tracks into estimates of maximum sustained wind speed in a 6-hour interval.

We model the maximum sustained wind speed at each of the cluster GPS-coordinates of our various household surveys to create a cyclone exposure variable, which is defined as experiencing winds that exceed the threshold of category one cyclone with sustained winds at >33 m/s (74 mph). We find that 21 per cent of households in the vanilla growing regions in the MICS 2018 were exposed to the cyclone, while none of the vanilla farmers in the DEMTREND panel were exposed to the cyclone.[4]

Our expectation is that the exposure to a cyclone negatively impacts durable asset ownership such that our wealth and household infrastructure and durable asset ownership results may be downward biased. We run an alternative specification where we exclude households in clusters that were exposed to tropical cyclone winds (that is, we exclude the households in MICS 2018 who were exposed to Enawo in 2017, as well as households that were in these locations in previous rounds). The results are reported in Table C4, and the estimates are very similar to our earlier results in Table 2 and Table B10.

C.3 Attrition and migration

We check whether attrition in the DEMTREND panel is affecting our results. The annual attrition in the panel is 2.1 per cent between 2003 and 2019, and 3.7 per cent during the two waves during which the cohort members were adults (2012 and 2019).[5]

To investigate whether our results are driven by selection into the sample in the follow-up waves, we rerun our main results in Tables 1, B5, and 4 with inverse probability weights adjusting for baseline characteristics in 2003. We adjust for the sex and age of the cohort member, household size, whether the household had electricity and a toilet, and the education level of the mother and father. The results for the full sample are presented in Table C7. We find that our results remain robust to the attrition adjustment.

[4]There were 21 non-vanilla farmer households in DEMTREND panel exposed to the cyclone. We have run our key results omitting these households, and the results are robust to this specification.

[5]In 2003, 2011 cohort members were interviewed, and in 2012, 1,735 of them were tracked. In the data collection that started in October 2019 we were able to find 1,341 cohort members from the 2003 cohort (of which 1,226 were interviewed in 2012, and the remaining 115 only in 2003) before the COVID-19 lockdown in March 2020. By then, all enumeration areas had been visited, but the data collection was still ongoing in localities where the re-interview rates were lowest.

Finally, we also check whether there has been differential migration to vanilla communities relative to and non-vanilla communities. This could be the case if vanilla production is providing lucrative economic opportunities within the communities producing them, that incentivize internal migration. While the repeated cross-sectional data does not allow us to follow individuals over time, the MICS 2018 contains questions on how long the respondent has been living in the current location. Table C5 reports the results, which show no differential migration towards vanilla communities relative to non-vanilla communities in the last 4 years, that is, during and before the vanilla price hike.

Table C1 – Wealth in vanilla-producing regions: using vanilla price

	Full sample		Rural		Urban	
	(1)	(2)	(3)	(4)	(5)	(6)
Vanilla commune × price	0.000495*	0.000672***	0.000444**	0.000511***	0.00114	0.00105
	(0.000294)	(0.000185)	(0.000223)	(0.000192)	(0.000920)	(0.000772)
Controls	No	Yes	No	Yes	No	Yes
Wave FE	Yes	Yes	Yes	Yes	Yes	Yes
District × vanilla FE	Yes	Yes	Yes	Yes	Yes	Yes
N	43040	43040	32465	32465	10575	10575
Mean of dep. var.	-3.86e-10	-3.86e-10	-0.284	-0.284	0.798	0.798

Notes: Data used is the MIS & MICS 4-wave repeated cross section. Vanilla price (in hundreds of USD) for each survey year is interacted with the vanilla commune indicator. The data for price is obtained from COMTRADE database and is as displayed in Figure 1b. The dependent variable is the wealth index. "Vanilla commune" indicates that vanilla was reported as one of the top 5 crops in the commune census. Wave FEs include dummies for years 2011, 2013 and 2018. Population weights are used in each regression. Robust standard errors in parentheses, adjusted for clustering at the district level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C2 – Wealth in vanilla-producing regions: 2013 as the reference year

	Full sample		Rural		Urban	
	(1)	(2)	(3)	(4)	(5)	(6)
Vanilla commune × 2018	0.214**	0.295***	0.221**	0.243***	0.364	0.339
	(0.0962)	(0.0575)	(0.0866)	(0.0629)	(0.441)	(0.379)
Vanilla commune × 2016	-0.307**	-0.116	-0.163	-0.0892	-0.193	-0.0987
	(0.131)	(0.104)	(0.111)	(0.0982)	(0.687)	(0.574)
Vanilla commune × 2011	-0.0695	0.0104	-0.00205	0.0186	-0.0563	-0.0458
	(0.101)	(0.0852)	(0.0832)	(0.0733)	(0.393)	(0.326)
Controls	No	Yes	No	Yes	No	Yes
Wave FE	Yes	Yes	Yes	Yes	Yes	Yes
District × vanilla FE	Yes	Yes	Yes	Yes	Yes	Yes
N	43040	43040	32465	32465	10575	10575
Mean of dep. var.	0.0497	0.0497	-0.241	-0.241	0.985	0.985

Notes: Data used is the MIS & MICS 4-wave repeated cross section. The dependent variables is the wealth index. "Vanilla commune" indicates that vanilla was reported as one of the top 5 crops in the commune census. Wave FEs include dummies for years 2011, 2016 and 2018, such that the 2013 round is used as the reference period. Population weights are used in each regression. Robust standard errors in parentheses, adjusted for clustering at the district level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C3 – Wealth in vanilla-producing regions: exclude 2016 data

	Full sample		Rural		Urban	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A.Post-dummy						
Vanilla commune × post	0.242**	0.278***	0.212***	0.217***	0.380	0.350
	(0.0961)	(0.0581)	(0.0777)	(0.0643)	(0.334)	(0.287)
Panel B. Year dummies						
Vanilla commune × 2018	0.197**	0.269***	0.207**	0.222***	0.352	0.335
	(0.0934)	(0.0604)	(0.0893)	(0.0666)	(0.435)	(0.383)
Vanilla commune × 2011	-0.0908	-0.0186	-0.00933	0.0102	-0.0658	-0.0380
	(0.105)	(0.0880)	(0.0829)	(0.0749)	(0.362)	(0.311)
Controls	No	Yes	No	Yes	No	Yes
Wave FE	Yes	Yes	Yes	Yes	Yes	Yes
District × vanilla FE	Yes	Yes	Yes	Yes	Yes	Yes
N	32416	32416	23824	23824	8592	8592
Mean of dep. var.	-3.86e-10	-3.86e-10	-0.284	-0.284	0.798	0.798

Notes: Data used is the MIS & MICS repeated cross section with the 2016 round dropped. The dependent variable is the wealth index. "Vanilla commune" indicates that vanilla was reported as one of the top 5 crops in the commune census. "Post" takes value one for the fourth round of the data 2018. Wave FEs include dummies for years 2011, and 2018, such that 2013 round is used as the reference period. Population weights are used in each regression. Robust standard errors in parentheses, adjusted for clustering at the district level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C4 – Wealth and assets in vanilla-producing regions: excluding areas affected by cyclone

	(1) Wealth index	(2) Mobile Phone	(3) Motorcycle	(4) Car	(5) Radio	(6) Bicycle	(7) Watch	(8) Bank Account	(9) Finished Roof
Vanilla commune × post	0.268***	0.158***	0.0627***	0.00290	0.0838*	-0.0279	0.0900**	0.00786	0.0731**
	(0.0640)	(0.0456)	(0.0230)	(0.00382)	(0.0427)	(0.0272)	(0.0430)	(0.0145)	(0.0292)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wave FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District × vanilla FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	31991	31909	31803	31800	31801	31801	31906	31990	31803
Mean of dep. var.	-0.284	0.403	0.0202	0.00562	0.413	0.167	0.185	0.0251	0.221

Notes: Data used is the MIS & MICS 4-wave repeated cross section; rural sample only. Clusters that were on the path of the Enawo cyclone are removed from each survey round of the data used. The dependent variable is the wealth index (in column 1) or an indicator for whether the household (or a member of the household) owns that particular asset. "Vanilla commune" indicates that vanilla was reported as one of the top 5 crops in the commune census. "Post" takes value one for the fourth round of the data 2018. Wave FEs include dummies for years 2011, 2013 and 2018. Population weights are used in each regression. Robust standard errors in parentheses, adjusted for clustering at the district level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C5 – Duration of residence at current location in 2018

	1 year or less		2 years or less		3 years or less		4 years or less	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Vanilla commune	0.00383	-0.00170	-0.00171	-0.00939	-0.00462	-0.0136	-0.0124	-0.0223
	(0.0120)	(0.0120)	(0.0143)	(0.0144)	(0.0147)	(0.0150)	(0.0161)	(0.0162)
Controls	No	Yes	No	Yes	No	Yes	No	Yes
N	12177	12177	12177	12177	12177	12177	12177	12177
Mean of dep. var.	0.0684	0.0684	0.107	0.107	0.141	0.141	0.170	0.170

Notes: Data used is the MICS 2018 rural sample. The dependent variables denote whether the respondent has lived in the same location within the last year, 2 years, 3 years and 4 years. Population weights are used in each regression. Robust standard errors in parentheses, adjusted for clustering at the commune level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C6 – Wealth of vanilla producers: new household formation

	(1)	(2)	(3)	(4)	(5)
Panel A. Full Sample					
Vanilla producer × post	0.462***	0.521***	0.520***		
	(0.171)	(0.179)	(0.180)		
New household			0.0129		
			(0.0646)		
Same household × producer × post				0.446***	0.757**
				(0.164)	(0.331)
New household × producer × post				0.609**	0.444***
				(0.247)	(0.152)
N	4099	2438	2438	2436	2438
R-Squared	0.620	0.756	0.756	0.756	0.757
Panel B. Vanilla Communes					
Vanilla producer × post	0.551***	0.493***	0.517***		
	(0.173)	(0.176)	(0.173)		
New household			-0.157		
			(0.0995)		
Same household × producer × post				0.478***	0.725**
				(0.171)	(0.320)
New household × producer × post				0.535**	0.427**
				(0.237)	(0.178)
N	872	548	548	548	548
R-Squared	0.620	0.745	0.746	0.745	0.748
Panel C. Restrict to agricultural households					
Vanilla producer × post	0.457***	0.476***	0.474**		
	(0.172)	(0.179)	(0.180)		
New household			0.0283		
			(0.0726)		
Same household × producer × post				0.402**	0.709**
				(0.164)	(0.336)
New household × producer × post				0.567**	0.400***
				(0.247)	(0.150)
N	3179	1930	1930	1930	1930
R-Squared	0.579	0.726	0.726	0.727	0.728
Wave FE	Yes	Yes	Yes	Yes	Yes
Household FEs	Yes	Yes	Yes	Yes	Yes
Survey waves	All	2-3	2-3	2-3	2-3
New household year				2012	2019

(see notes on next page)

Notes: Data used is the DEMTREND cohort panel. The dependent variable is the household asset index, standardized by the mean and standard deviation of the non-vanilla producing households in wave 3. Column 1 repeats the baseline estimate from our main results. In columns 2-5, we restrict the analysis to waves 2 and 3. In column 3, we control for a time-varying "New household" indicator that takes value 1 if the cohort member has moved out of their original household from 2003. In columns 4 and 5, we interact the producer variable with *time-invariant* indicators of household formation: in column 4, "new household" takes value 1 for individuals who change households between 2003 and 2012; while in column 5, "new household" takes value 1 for individuals who change households between 2012 and 2019. Robust standard errors in parentheses, adjusted for clustering at the zone level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C7 – Outcomes of vanilla producers: adjusted for attrition

(a) Wealth and financial outcomes

	(1) Wealth	(2) Formal savings	(3) Informal savings	(4) Loans	(5) Received remittances	(6) Sent remittances
Vanilla producer × post	0.458***	-0.0382	0.375***	-0.0681	-0.0972**	-0.0329
	(0.168)	(0.138)	(0.0748)	(0.0927)	(0.0373)	(0.0446)
Household FEs	Yes	Yes	Yes	Yes	Yes	Yes
Wave FEs	Yes	Yes	Yes	Yes	Yes	Yes
N	4099	4224	4224	4224	4224	2640

(b) Labor outcomes

	Worked in last 12 mos		Agriculture		Unpaid work (mins/day)	
	(1)	(2)	(3)	(4)	(5)	(6)
	Worked	Hours	Agriculture occupation	Hours in agriculture	Caring for children	All other activities
	(1)	(2)	(3)	(4)	(5)	(6)
Vanilla producer × post	-0.0521	95.91	0.180***	628.0***	-13.06	-37.61**
	(0.0865)	(194.8)	(0.0558)	(170.3)	(10.94)	(16.78)
Household FEs	Yes	Yes	Yes	Yes	Yes	Yes
Wave FEs	Yes	Yes	Yes	Yes	Yes	Yes
N	2488	2634	1902	2618	2480	2546

(c) Psychological well-being and cognitive test scores

	Emotional Stability		Cognitive Tests	
	(1) Average	(2) Factor	(3) French	(4) Math
Vanilla producer × post	0.208**	0.353*	0.0193	0.0691***
	(0.104)	(0.194)	(0.0331)	(0.0252)
Wave FE	Yes	Yes	Yes	Yes
Household FEs	Yes	Yes	Yes	Yes
N	2366	2366	2386	2386

Notes: Data used is the DEMTREND cohort panel, full sample (corresponding to Panel A in Tables 1, B5, 3, and 4). "Vanilla producer" indicates that household produced vanilla during wave 3 of the household survey in 2019. "Post" takes value one for the 2019 wave. Wave FEs include dummies for years 2003, 2012 and 2019. The variables considered for the Inverse Probability Weighting are: sex and age of the cohort member, household size, a dummy for household electricity access, a dummy for toilet, mother's education level and father's education level measured in wave 1. Results are displayed for the full sample. Robust standard errors in parentheses, adjusted for clustering at the zone level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.