FLINT

EFFECT OF AGE OF ASSETS ON FARM PROFITABILITY AND LABOUR PRODUCTIVITY

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ABOUT THE FLINT PROJECT

FLINT provide an updated data infrastructure needed by the agro-food sector and policy makers to supply up-to-date information on farm level indicators on sustainability and other new, relevant issues. By taking into account the sustainability performance of farms, better decision making will be facilitated on a wide range of relevant topics, such as (1) market stabilisation; (2) income support; (3) environmental sustainability; (4) climate change adaptation and mitigation; (5) innovation; and (6) resource efficiency. The approach will explicitly consider the heterogeneity of the farming sector in the EU and its Member States (MS). The feasibility of these indicators will be determined in both the farming and agro-food sectors.

FLINT will take into account the increasing needs for sustainability information by national and international retail and agro-food sectors. The FLINT approach is supported by the Sustainable Agriculture Initiative Platform and the Sustainability Consortium in which the agro-food sector actively participates. FLINT will establish a pilot network of at least 1000 farms (representative of farm diversity at EU level, including the different administrative environments in the different MS) that is well suited for the gathering of these data.

The lessons learned and recommendations from the empirical research conducted in nine purposefully chosen MS will be used for estimating and discussing effects in all 28 MS. This will be very useful if the European Commission should decide to upgrade the pilot network to an operational EU-wide system.

PROJECT CONSORTIUM:

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LIST OF ACRONYMS

ATT	Average Treatment Effect
AWU	Annual Work Unit
CAP	Common Agricultural Policy
EC	European Commission
SO	Standard Output

EXECUTIVE SUMMARY

The aim of this study is to find out whether there is a strong connection between the age of assets on the one hand, and profitability and environmental sustainability on the other hand, for farms in the European Union. Such study can help contribute to the question whether it is worth supporting investments that contribute to technical changes in agricultural production and ensure the enterprise's operations and growth in the long term and over its life cycle. Throughout our study we showed the importance of investments which contribute to improving the production of goods and to promoting technical and economic progress in a sustainable way. The main principle of the selected analytical approach was that propensity score matching largely eliminates selection bias, thus making comparisons between treated (in our case investors) and control groups more reliable. As a consequence, the estimated effect of age of machinery on result indicators was found to be positive. The output per total fixed assets was higher for farms considered as investors (machinery age less than six years) compared with the control group. Concerning the impact of age of machinery on labour productivity, we found, in line with our expectation, that agricultural companies where the average age of machinery is less than six years, produce 62 percent more output per annual work unit than those farms where the average age of machinery is more than six years.

1 INTRODUCTION

Investment is an important factor in sustainable development. Improved production and marketing, transfer of financial resources and sharing of knowledge are critical to ensure that economic growth leads to social development, while preserving or enhancing the natural resource base. Decisions about how and where to invest reflect the strategic direction of the enterprise (SAFA, 2013).

In this study we investigate the impact of farm investment subsidies in an indirect way. Some of the evaluation questions focus for example on the direct effect of one of the rural development programmes on a specific result indicator (Michalek, 2012). Our approach is more general. No special programme was selected to evaluate, owing to the fact that long time series were not available and data referring to age of assets concerned only the accounting year 2015 or 2014.

The term 'investment' is seen from a micro-economic perspective, namely putting money into something with a view to gain. Through its investments and business activities, the enterprise enhances its sustainability performance and has the capacity to generate a positive net income. To be considered economically sustainable, an enterprise should be capable of paying all its debts, generating a positive cash flow, compensating for the negative externalities it may generate, and adequately remunerating workers and shareholders. Investment in infrastructure through modernisation of equipment generates technical change and technological advancement which, from a farm perspective, should result in increased return (SAFA, 2013).

The aim of this study is not to evaluate 'ex post' rural development programmes, but to show that there is a strong connection between the level of development (age of assets) and profitability and environmental sustainability, and that it is worth financing investments that contribute to technical changes in agricultural production and ensure the enterprise's operations and growth in the long term and over its life cycle. Throughout our study we show indirectly the right to existence of those investment subsidies which contribute to improving the production of goods and to promoting technical and economic progress in a sustainable way.

An important obstacle in such an analysis has up to now been the lack of data. The analysis here relies on the data collected via the FLINT project. These are farm-level data for a sample of farmers of the Farm Accountancy Data Network (FADN) in several European Union (EU) Member States (the Netherlands, Hungary, Finland, Poland, Spain, Ireland, Greece, France and Germany). The data include accountancy data from FADN (here after: 'FADN data') as well as additional data on economic, environmental and social sustainability of farms. These additional data, the 'FLINT data', were collected via face-to-face survey or merging of existing data, depending on the country. The FADN and FLINT data relate to accountancy year 2015, except for France and Germany for which it is 2014.

Through FLINT data collection, information was collected on the number and average age of assets by different machinery and building categories at the farm level. Based on this information, the indicator 'average age of machinery and buildings' was calculated. The average age of assets (machinery, building) of a given farm can reflect the level of development which has influence on labour productivity, capital productivity, farm income, energy efficiency (reduced costs due to innovative technologies) and environmental sustainability. The analytical approach applied in this study was propensity score matching where, in addition to the national distinctions, the type and the size of the farm were taken into account.

In recent years the evaluation of EU Member States' co-founded programmes was assigned particular importance. The administrative reform of the European Community (Agenda 2000) confirmed the significance of the monitoring and evaluation components, and extended periodic evaluation to all EU policies (Toulemonde *et al*., 2002). Meanwhile, evaluation has been recognised as a crucial component of policy development and has become an integral part of EU programming at all levels, e.g. EU, national, and territorial (Vanhove, 1999; Ederveen, 2003; EC, 1999, 2002a, 2002b).

The major criticism of the existing EU common evaluation system and common indicators concerned: i) the relevance and appropriateness of particular indicators suggested by the European Commission (EC);

ii) the lack of a coherent evaluation framework linking inputs, iii) gaps in data in the programmes' monitoring systems, and iv) the lack of prioritisation between many indicators (e.g. Forstner and Plankl, 2004; CEAS 2003). If the EC should decide to upgrade the FLINT pilot network to an operational EU-wide system, then the information gained from the FLINT data collection can serve the data needs of an extended evolutional tool which can be used for monitoring and evaluation of rural development programmes.

2 METHODOLOGY AND DATA

2.1 Methodology

Owing to data constraints, the assessment of the effect of using advanced technology was limited. The main principle of the analytical approach chosen was that propensity score matching largely eliminates selection bias, thus making comparisons between treated (in our case investors) and control groups more reliable.

2.1.1 Calculation of age of assets

The initial step was to calculate the average age of assets. The EU FADN collects data on the value and depreciation of assets. However, these collected data do not provide enough information to calculate the average age, since the second-hand machinery would distort the results. In FLINT, data have been collected for the most relevant groups of machinery and buildings. For the machinery, 19 groups have been distinguished. Six different groups have been established just for tractors, based on their performance. Different building units were defined according to their construction. Livestock buildings are expressed in places, the different storage places in m^2 or m^3, and wine storage equipment in litres. These bases are still very different; therefore, we encountered difficulties in creating a composite indicator for age of assets. We decided to create a composite indicator for age of machinery, since the structure of assets is more homogenous in the same farm type. The following farm types have been involved in the calculation: dairy farms, sheep farms, pig farms and wineries.

The age of machinery could not be calculated on the basis of simple mathematical average. Each element of machinery has a considerably different acquisition cost. To address this issue we applied a weighting scheme. The factors have been calculated based on the average investment cost of each machinery item. Owing to limited international sources of this information we decided to use the data of the Hungarian statistics. Based on the EU FADN results, Hungary is at an average level in terms of economic indicators so it provides a good basis to calculate the weighting factor among the machinery groups.

2.1.2 Propensity score matching

The analytical approach applied in this study is propensity score matching. This technique was first published by Rosenbaum and Rubin (1983). Propensity score matching is a statistical matching technique that attempts to estimate the effect of a treatment, policy or other intervention by accounting for the covariates that predict receiving the treatment.

In our study we assumed that where the average age of machinery is less than six years there was investment in the past few years and therefore these farms are considered as investors and all the other farms which have no significant investment are considered as the control group. Owing to the lack of long time series the source of investment was not investigated; the existence of investment subsidies was not taken into account in the calculation.

The evaluation methodology was applied in the following steps (based on the description of Michalek, 2012): *Firstly,* calculation of individual propensity scores. The propensity scores for each observation in the investors and the non-investors sample of farms were econometrically estimated using the predicted values from a standard logit-model. The list of variables selected as covariates to estimate the logit function is as follows: country, type of farming, total standard output. *Secondly,* exclusion of non-similar farms from the control group. Some of the investors and non-investors units were excluded from further comparisons because their propensity scores were outside the range calculated for investors units. Out of several alternative matching algorithms, radius matching was used. This method can be

considered as a variation of the nearest neighbour method. By using radius matching, bad matches can be avoided by imposing a tolerance level on the maximum propensity score distance. The disadvantage of this method is the difficulty to know a priori what tolerance level is reasonable (Smith and Todd, 2005). In our case the radius is 0.001. *Thirdly*, calculation of relevant outcome indicators. The mean values of the outcome indicator for comparable supported and control units were computed using the matching algorithm. *Fourthly*, calculation of the most important policy parameter, namely the Average Treatment Effect (ATT) on treated. The ATT measures the difference in mean (average) outcomes between farms in the treatment group and farms in the control group. *Fifthly,* estimation of the effect of age of machinery.

The sample farms were very heterogeneous in terms of farming activity and the quantity of fixed assets. In order to eliminate the possibility that small farms (with low amount of fixed assets) influence the results significantly, total assets per farm (FADN code SE441) was applied as weight.

2.2 Data

The database contains the data of 1101 farms where all relevant information needed for the calculation were available such as FADN data, FLINT data, standard results and typology (size and type of the farm). After cleaning the database (by dropping from the set of potential controls those farms which have improbable values) 1093 farms remained to be analysed. Another 23 farms were deleted from the sample because they had no machinery at all and contractors were used for agricultural production. Some of the farms were left out due to their size because, owing to the lack of weights, their data extensively influenced the results. In the calculation the data of all the nine Member States involved in the FLINT project were taken into account and there was no specification for the size and the type of farming.

The aim was to show that there is strong connection between the age of assets and the selected outcome variables (result indicators) which reflect the effect of technical development at a micro-level: e.g. income, profits, employment, gross production value and labour productivity. The list of indicators used for the calculation is provided in Table 1.

Table 1. List of variables

Name	Source	Description
Age of assets in terms of machinery	FLINT	Economic indicator which reflects the level of development of the farm
SE131/SE441	FADN	Total output per total fixed assets
SE410/SE441	FADN	Gross farm income per total fixed assets
SE275/SE131	FADN	Total intermediate consumption per total output
SE131/SE010	FADN	Total output per annual work unit
SE485/standard output*	FADN	Total liabilities per standard output
SE455+SE450/standard output	FADN	The value of buildings and machinery per standard output

*: The Standard Output (SO) is the average monetary value of the agricultural output at farm-gate price of each agricultural product (crop or livestock) in a given region. The SO is calculated by Member States per hectare or per head of livestock, by using basic data for a reference period of 5 successive years. The SO of the farm holding is calculated as the sum of the SO of each agricultural product present in the holding multiplied by the relevant number of hectares or heads of livestock of the holding.

Table 2. Descriptive statistics of the sample referring to the variables used

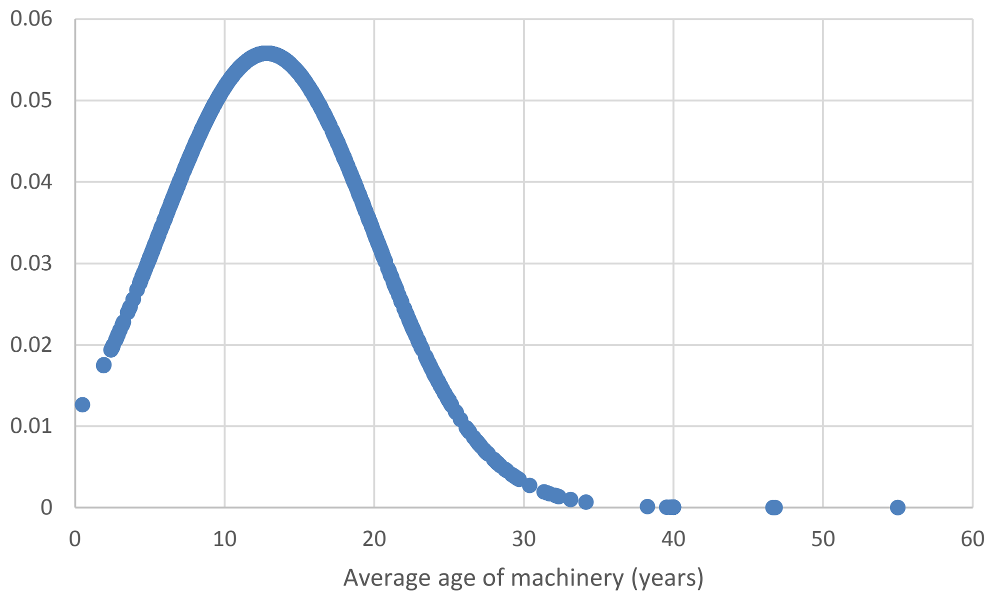
	mean	min.	max.	std.dev.
Age of machinery (years)	13.28	0.50	55.00	7.16
SE131/SE441	0.31	0.02	113.90	3.58
SE410/SE441	0.15	-1.55	83.89	2.62
SE275/SE131	0.54	0.07	4.52	0.35
SE131/SE010 (Euro/AWU))	178 523	2 959	1 215 754	112 915
SE485/standard output	2.18	0.00	53.69	2.27
SE455+SE450/standard output	1.37	0.003	11.45	1.50
SE441 (Euro)	741 662	505	31 489 298	1 591 838

Source: Own calculation by AKI

Descriptive statistics provided in table 2 describe the basic features of the data used in this study. The sample farms were very heterogeneous in terms of size and type of farming therefore further stratification of the sample was not applied (because the sample size would be very low in the given cluster).

The average age of machinery in the sample is 13.8 years. There are four big farms (total standard output is more than EUR 95 000) of which the average age of machinery is more than 40 years (Figure 1).

Figure 1. Density function of age of machinery in the sample



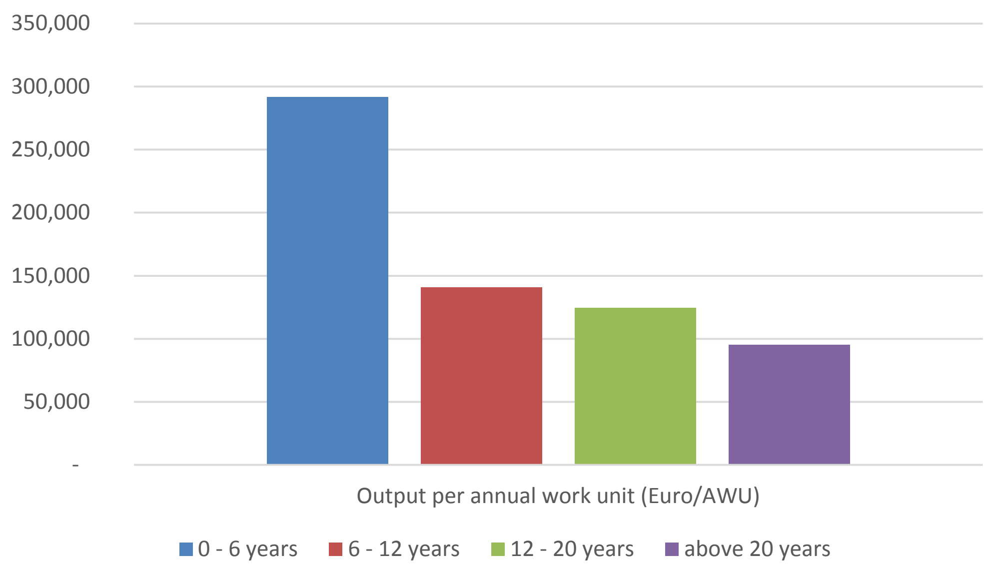
Source: Own calculation by AKI

The sample farms were divided into four groups based on the average age of machinery used for agricultural production. The estimation of effect of age of machinery by computing the mean of results indicators by different age groups shows very high impact on the performance of agricultural companies. The lower the average age of machinery, the higher the output per total fixed assets, labour productivity and gross farm income per total fixed assets (Figures 2 and 3).

Figure 2. Results indicators by different age groups of machinery

Source: Own calculation by AKI

Figure 3. Output per annual work unit (Euro/AWU) by different age groups of machinery



Source: Own calculation by AKI

3 RESULTS

On the basis of the available FADN and FLINT database, 1070 farms were selected for further analysis, which was performed for the accounting years 2014/2015. The sample farms were divided into two groups. The first group contains those farms where the average age of machinery is less than or equal than six years. These farms are considered as investors. All the other farms (where the average age of machinery is more than six years) are considered as non-investors. A further 201 farms were removed from the sample because their result indicators were considered as extreme outliers. For the analysis of outliers, box plot was used. After cleaning the data, 869 farms remained in the sample. An analysis of some key characteristics of the selected groups of farms (investors D=1 vs. non-investors D=0) shows that these two groups differed considerably (Table 3).

Table 3. Major characteristics of farms (investors D(0) vs. non-investors D(1))

	Number of farms in the sample	Total liabilities per standard output	Value of machinery and buildings per standard output	Total standard output per farm (Euro)	Output per annual work unit (Euro/AWU)
D(0)	786	1.14	1.02	236 083	150 329
D(1)	83	1.40	1.21	328 243	199 553

Source: Own calculation by AKI

Farms with an age of machinery of less than six years have more short and long term loans, and the value of machinery and building per standard output and the labour productivity are higher compared with those agricultural companies where the average age of machinery is more than six years.

Given the individual characteristics of agricultural companies (investors vs. non-investors), propensity scores were estimated for all selected enterprises using a logit function. The selection of covariates from a given set of available characteristics (FADN data) was based on economic theory and some empirical evidence. The variables that appeared statistically as the most significant and simultaneously satisfied the balancing property tests were the total standard output of the farm, type of farming and country. The results of logit estimation are shown in Table 4.

Table 4. Results of estimation of logit function on investors vs. non-investors

	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
Total standard output	7.88E-07	9.67E-08	8.15	0	5.98E-07	9.77E-07
Country: Germany	1.370737	0.4416047	3.1	0.002	0.505208	2.236266
Country: Spain	2.266996	0.3347208	6.77	0	1.610955	2.923036
Country: France	1.406122	0.3126053	4.5	0	0.793427	2.018817
Type of farming: Mixed crops-livestock	-2.36313	0.9331795	-2.53	0.011	-4.19213	-0.53413
Type of farming: Mixed cropping	-2.85347	1.155891	-2.47	0.014	-5.11897	-0.58797
Country: Netherlands	-2.710785	0.6942758	-3.9	0	-4.07154	-1.35003
Country: Poland	1.01564	0.3800359	2.67	0.008	0.270784	1.760497
Type of farming: Specialist field crops	-2.134133	0.9248984	-2.31	0.021	-3.9469	-0.32137
Type of farming: Specialist permanent crops	-2.21611	0.9678974	-2.29	0.022	-4.11315	-0.31907
Type of farming: Specialist grazing livestock	-2.85139	0.9375316	-3.04	0.002	-4.68892	-1.01386
Type of farming: Specialist granivores	-2.46411	1.00361	-2.46	0.014	-4.43115	-0.49707
Intercept	-0.9255513	0.9957174	-0.93	0.353	-2.87712	1.026019
Logistic regression	Number of observations	LR chi2(12)	Prob > chi2	Pseudo R2	Log likelihood	
	869	644.52	0	0.4818	-346.57057	

Source: Own calculation by AKI

The assessment of micro-economic effect that a farm applies advanced technology on agricultural production can be carried out using various farm-specific economic coefficients as result indicators. In this study we selected four relevant result indicators available from FADN system:

- Output per total fixed assets
- Gross farm income per total fixed assets
- Intermediate consumption per output
- Output per annual work unit (Euro/AWU)

In order to measure the effect of the age of assets on farms the ATT, coefficients were estimated for each result indicator. The outcomes of ATT estimations are shown in Table 5. The results show significant difference ($p<0.01$) between investors and control group in case of output per total fixed assets, intermediate consumption per output and output per annual work unit. Referring to gross farm income per total fixed assets the difference was not substantial.

Table 5. Effect of age of machinery on result indicators

	ATT	Std. Err.	t
Output per total fixed assets	0.183***	0.062	2.947
Gross farm income per total fixed assets	0.031	0.021	1.451
Intermediate consumption per output	0.077***	0.035	2.211
Output per annual work unit (Euro/AWU)	35 060.589***	8 804.933	3.982

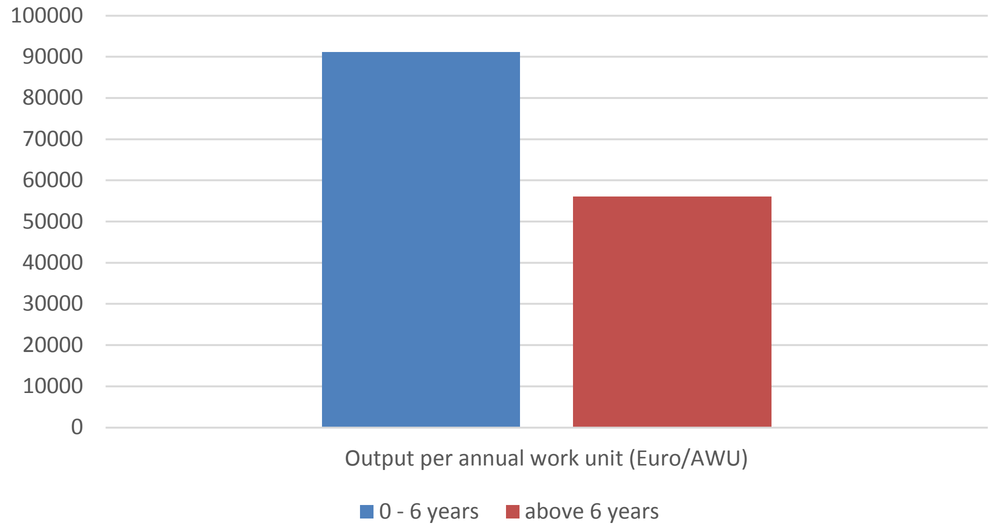
Source: Own calculation by AKI

The effects of age of machinery were computed on the basis of the estimated differences between the investors and control group (ATT). The results of this estimation on output, gross farm income, intermediate consumption and labour productivity are shown in Figures 4 and 5.

Figure 4. Effect (based on ATT) of age of machinery on output, gross farm income and intermediate consumption

Source: Own calculation by AKI

Figure 5. Effect (based on ATT) of age of machinery on labour productivity



Source: Own calculation by AKI

As a consequence, the estimated effect of age of machinery on result indicators was found to be positive. The output per total fixed assets and the gross farm income per total fixed assets were higher, for farms considered as investors compared with the control group. Concerning the impact of age of machinery on labour productivity we found, in line with our expectation, that farms where the average age of machinery is less than six years produce 62 per cent more output per annual work unit than those farms where the average age of machinery is more than six years. Concerning the impact of age of machinery on costs we found that, contrary to some expectation, intermediate consumption per output was higher by 0.07 percentage point in case of farms where the age of machinery was lower than six years compared with the control group. The results show, that farms which apply advanced technologies produce more intensively.

4 CONCLUSION

The purpose of farm investment aid is to modernise agricultural holdings to improve their economic performance through more efficient use of the production factors including the introduction of new technologies and innovation. On the basis on this study we could show that there is a close link between the age of assets and farm performance in terms profitability and labour productivity. Those farms where the average age of machinery is less than six years produce 62 per cent more output per annual work unit compared those farms where the average age of machinery is more than six years.

The EU FADN collects data on value and depreciation of assets. However, these collected data do not provide enough information to calculate their average age, since the second-hand machinery would distort the results. In FLINT we could collect directly data on average age of assets and in this way the impact of age structure of capital goods can be directly evaluated. In the pilot FLINT data collection time series were not available to examine direct connection between the effect of age of asset and investment subsidies, therefore drawing only indirect conclusions on such subsidies was possible. If the EC decides to turn the pilot network to an operational EU-wide system and long-time series become available, the information on age of assets would be useful for the evaluation of the effect of investment subsidies.

Throughout our study we showed the importance of those investments which contribute to improving the production of goods and to promoting technical and economic progress in a sustainable way. The results stress the importance of promoting investments, whether through subsidisation or through other means.

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