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Software Ecosystems: Vendor-Sided Characteristics of Online Marketplaces

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Abstract: For several years, marketplaces exist in the software industry, where customers can, for instance, search for specific services offered by different vendors, review, buy and use these services. The vendor-sided characteristics of these marketplaces are widely discussed but have not yet been investigated in detail.

In this paper, we consider online marketplaces and the participants as part of a Software Ecosystem. First, we derive vendor-sided characteristics of a Software Ecosystem from existing literature and introduce FaDOM – a newly developed software **F**ramework for **A**utomated **D**ata Collection in **O**nline **M**arketplaces. On basis of the collected data, we analyze vendor-sided characteristics of five online marketplaces.

1 Introduction

The analysis of Software Ecosystems (SECOs) is a recently developing field in IS research. SECOs are defined as „a set of actors functioning as a unit and interacting with a shared market for software and services, together with the relationships among them. These relationships are frequently underpinned by a common technological platform or market and operate through the exchange of information, resources and artifacts" [JBF09]. A contemporary example for SECOs are online marketplaces for Software as a Service (SaaS) where customers can, for example, search for specific services offered by different vendors, review, buy and use these services.

Since research on SECOs resides in an early stage, the characterization of SECOs is a major open research question [JFB09]. This paper builds on the literature regarding the characterization of SECOs and presents first empirical data. The results can serve as a foundation of further investigations and are relevant for practice as well as academia. Since various analyses are only possible based on longitudinal data, we rely on automatically collectable and publicly available information. In this article we introduce FaDOM – a newly developed software **F**ramework for **A**utomated **D**ata Collection in **O**nline **M**arketplaces.

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Subsequent to this short introduction, we present an examination of vendor-sided characteristics of online marketplaces in the context of SECOs (section 2). In section 3, the architecture of FaDOM is described. Section 4 presents the analysis of data collected by FaDOM on five online marketplaces in a descriptive way. We carefully try to deliver possible explanations for the data and use visualization to gain additional insights compared to a mere analytical approach [Ba09]. Afterwards, we conclude our work by discussing and interpreting the results beyond the presented statistics and give an outlook on further research (section 5).

2 Online Marketplaces as Software Ecosystems

In the environment of SaaS solutions a growing number of marketplaces based on software platforms emerged during the last years. These marketplaces can be considered as SECOs as defined above and will be examined hereafter. Since 2006 *salesforce.com* provides – besides its SaaS CRM solutions – a marketplace called *AppExchange* where applications are dealt that complement the salesforce.com CRM suite. These applications can be offered either by independent software vendors (ISVs) or by the marketplace provider. By opening its marketplace for 3rd party applications *salesforce.com* established a Software Ecosystem around its core product. Other Software vendors followed that strategy. In the field of SaaS business solutions the companies *SugarCRM* (with *SugarExchange*) and *NetSuite* (with *SuiteApp.com*) launched comparable marketplaces in 2006 and 2009 respectively. But not only pure SaaS vendors pursue the approach of building a Software Ecosystem around their core products. Since 2008 *Microsoft*'s marketplace *Pinpoint* is being operated and in 2010 *Google* followed with the *Google Apps Marketplace*, where 3rd party providers can offer their applications around the core product *Google Apps*.

In a growing body of literature, several characteristics of SECOs are derived. These can be divided into customer-sided and vendor-sided characteristics – in the remainder of the article we focus on vendor-sided characteristics of SECOs.

Table 1 illustrates the vendor-sided characteristics of online marketplaces (column 1) and shows whether these can be derived based on publicly available information on the website of the marketplace (column 2) and if the collected data is automatically analyzable (column 3). The structure of the table is based on [JBF09] who cluster the characteristics into the categories *composition of vendors, entry barriers* and *stability*. Furthermore, *pricing* within the ecosystem [JBF09] and *multi-homing* [EPA09] represent characteristics of a SECO that are also discussed in literature on two-sided markets (cf. [Ha09] for pricing and [Ar06] for multi-homing).

The characteristics *number*, *size*, and *role* (of vendors) are subsumed into the category *composition of vendors*. The *number* of vendors determines the size of the ecosystem [JBF09] whereas the *size* of a specific vendor can be measured by the number of applications he/she offers. Both characteristics can be culled from the website and automatically be evaluated. Possible *roles* for a vendor are described by [IL04a] as well as [GC02]. The *roles* can be differentiated, e.g., by the extent of actively taking part

within the ecosystem [Ad06]. These *roles* cannot be investigated by simple website analysis. However, the *roles* in an online marketplace can be determined by analyzing partner programs offered by the provider of a marketplace.

Characteristics	Collectable via website	Automatically analyzable
Composition of vendors	(✓)	(✓)
Number	✓	✓
Size	✓	✓
Role	✗	✗
Entry barriers	✗	✗
Stability	(✓)	(✓)
History	✓	✓
Health		
- Robustness	(✓)	(✓)
- Productivity	✗	✗
- Niche creation	(✓)	(✓)
Pricing	✓	(✓)
Multi-homing	✓	✓
✓ = Yes; ✗ = No; (✓) = partly		

Table 1: Vendor-sided characteristics of online marketplaces

The *entry barriers* – as the second category stated by [JBF09] – cannot be covered by website analysis either. In this case the information can be collected from the marketplaces' business models. The revenue model of the marketplace [Ha06], usage of proprietary standards [Bo09] and provided languages are examples for entry barriers into the SECO.

The third category refers to the *stability* of the ecosystem and comprises the *history* [JBF09] of a marketplace and its *health* [IL04c]. *History* describes the evolution of a SECO and can be derived by website analysis if the data is collected repeatedly (e.g., every week) and stored with a timestamp. *Health* of an ecosystem is defined by [IL04a] as a combination of *robustness* (the capability "of facing and surviving perturbations and disruptions"), *productivity* ("the effectiveness […] in converting innovation into lowered costs and new products and functions") and *niche creation* ("the capacity to create new valuable niches") and a list of factors that make up these three determinants. [dH06] operationalize these factors and proposes how to measure them. Some of the factors are available on the websites of the marketplaces, while others cannot be collected by website analysis. Regarding *robustness* it is possible to determine survival rates ("Number of startups and bankrupt companies over multiple years" [dH06]) since these can be derived from historical data. For every point in time it can be assessed which vendors are part of the ecosystem and which ones are not (anymore). Persistence of structure in the marketplace can also be investigated in that matter ("Number of relations and number of agents measured per year subject to structural changes" [dH06]). *Productivity* – as the second determinant – cannot be collected by simple website analysis since the data that is needed to calculate productivity is not publicly available. Nevertheless, [dH06] come forward with some suggestions how to measure productivity if the necessary data is available. *Niche creation* is defined by the two factors variety ("the number of […] categories, products, and/or businesses being created within the ecosystem" [IL04b]) and value creation ("The overall value of new options created"

[IL04b]). Variety could be covered by observing the size of different categories over time (in terms of applications listed in each category [IL04a]). It is not possible to derive the factor value creation since the necessary data (profits and turnover [dH06]) to calculate value creation is not available on the marketplaces.

Pricing in an ecosystem can be regarded from different perspectives. In the context of online marketplaces two stages of pricing can be distinguished: the marketplace provider has his/her revenue model towards 3rd party providers [Ro05] and these vendors have own pricing models for their offerings [LB09]. Both stages can be observed: the marketplace's pricing via its revenue model and the price models that are applied by the application providers from their websites. Since pricing information is mostly a text field in the implementations of the marketplaces, there is a barrier for an automatic analysis at this point.
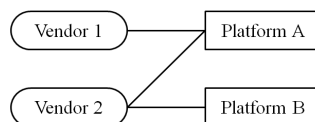

Figure 1: Vendor-sided single- and multi-homing (based on [RT06])

When multiple platforms exist in a market, a vendor can decide on which platform(s) he/she wants to offer his/her services. Figure 1 illustrates such a scenario: If a vendor chooses only one platform (Vendor 1) this is called single-homing [PV06]; if more than one platform is being served by a single vendor (Vendor 2) one speaks of *multi-homing* [RT03]. Regarding multi-homing, there is no unique theory known to the authors which explains when and why (under which circumstances) this characteristic occurs. Basically, multi-homing can be seen as a trade-off between a limited (potential) transaction volume on the platforms that are already being served and the costs for the exploitation of a new platform [RT03] [Le09].

Table 1 exhibits that most of the vendor-sided characteristics of SECOs are (at least partly) collectable by the analysis of the marketplaces' websites. Furthermore, especially history and robustness related aspects demand a repeated and automated analysis. [ILV06] pursued a similar approach by analyzing network metrics within the software industry. While they concentrated on the links between different software firms, we extend the analysis to the characteristics of a SECO derived in Table 1.

3 FaDOM – A Framework for Automated Data Collection in Online Marketplaces

To analyze the vendor-sided characteristics, we developed the "**F**ramework for **A**utomated **D**ata Collection in **O**nline **M**arketplaces" (FaDOM). FaDOM supports the automated collection of application specific metadata (in the remainder of the article: metadata) in online marketplaces on a regular basis. This allows to analyze specific metadata which can also be aggregated and evaluated statistically in order to reveal medium or long term developments of the marketplaces (e.g., the effects of a strategic

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www.informatik2011.de

change of a marketplace provider). FaDOM is implemented in Java and will be provided upon request in order to support the data collection by other researchers.

The architecture of FaDOM consists of two layers: the *universal layer* and the *market layer*. The universal layer provides basic functionalities (e.g., database management) that are used for all analyzed marketplaces. The market layer consists of all marketplace specific customizations, which are caused by the different designs of the analyzed web pages for example. In the following we use the term *market implementation* for an implementation on the market layer for a specific marketplace. The two layers will be explained in further detail in the following sections.

3.1 Layer 1: Universal layer

By incorporating functionalities for all market implementations, the universal layer avoids redundancy. Its main function is the management of storage of all captured metadata in a database (MySQL). Each of the market implementations uses the same generic structure of data tables. The structure consists of four tables holding the master data, price, version and additional information.

The *master data* of the application includes its name, an identification key defined by the marketplace, manufacturer information, system requirements, available languages, trial-version information, marketplace categories and the timestamp of the data collection. The table *price information* holds the price model: timestamp, price of each application (and possible application variants), and the assessment base (time, user, etc.). The table *version information* contains the version name, date of release, size of the application and number of downloads. The table *additional information* contains further metadata, especially the amount and level of application ratings and reviews.

The assignment of the metadata to the tables is based on the differing validity periods of the respective information. Master data typically remains constant for a long period. In contrast, there is also data that changes frequently (e.g., ratings). Typically, not all metadata stored in the database is available on every marketplace. By configuring the universal layer, every market implementation determines the utilisation of the needed data entries.

3.2 Layer 2: Market layer

Due to the functionalities offered by the universal layer, the development of a new market implementation merely consists of three steps. In the first step the universal layer has to be configured and the data tables of the generic template need to be initialized. In the second step the code to traverse the marketplace has to be implemented. In some cases this is just a traversing of a complete listing of applications (e.g., Google Apps marketplace). In other cases it might be necessary to traverse all categories of applications and the sub listings (e.g., Pinpoint). In the third development step the implementation work for the actual collection of metadata for the applications from their websites needs to be done.

The second and third steps require a technical evaluation of the analyzed websites. For example, the analyses of websites depending on "Asynchronous JavaScript and XML" (AJAX) differ distinctively. The content of websites without AJAX can easily be assembled in Java by reading-in Uniform Resources Locators (URLs). In that case, the market implementations transform the websites into Document-Object-Model objects (DOM-objects) for an easier evaluation. For this purpose, the market implementations use the open source package NekoHTML.

In some cases, an AJAX-based web page does not support views of the content via URLs (e.g., Pinpoint and AppExchange). In those cases we use the open source solution Watij. Watij, originally designed for website tests, is able to control the Internet Explorer remotely via Java. The evaluation of the website is carried out with DOM objects, as in the case without AJAX.

4 Vendor-sided characteristics of five Software Ecosystems

Below, we present an overview of vendor-sided characteristics of SECOs (cf. section 2) based on the collected data of five SaaS marketplaces. Such an overview is not available yet and may be used to develop a formal charaterization of SECOs. The considered marketplaces are examined on a weekly basis. Table 2 shows the date of the first investigation (please note: due to the necessary development of different market implementations, the marketplaces differ in the date of the first investigation).

It is important to note that all analyses for the Apps Marketplace refer to the marketplace specific listing category "Products". This approach avoids (on premise) "Installable products" and "Professional Services" to be listed in the analysis which are not within the scope of AppExchange, SugarExchange or SuiteApp.com. For the same reason the analysis of Pinpoint is restricted to "Online Applications". Furthermore, we examine the U.S. version of Pinpoint.

Online marketplace	First investigation
salesforce.com AppExchange	Apr. 26th, 2010
Google Apps Marketplace	May 5th, 2010
Microsoft Pinpoint	July 13th, 2010
SugarCRM SugarExchange	July 16th, 2010
NetSuite SuiteApp.com	Sept. 20th, 2010

Table 2: First investigation of the marketplaces (followed by an investigation on a weekly basis)

The collected metadata is used to analyze the vendor-sided characteristics of online marketplaces specified in section 2. If not stated otherwise, all results are based on metadata collected on November 1st, 2010. First of all, we will show the composition of vendors including the number and size of those vendors as well as the overall number of applications which can be derived from the latter two indicators. Second, we will analyze vendor-sided stability including the number and size of vendors over time. Furthermore, the persistence of the vendor structure will be analyzed over time. Subsequently, we will give a brief overview of the pricing structures. Finally, vendor-sided multi-homing will be illustrated.

4.1 Composition of vendors

FaDOM allows to analyze the composition of vendors. As already mentioned above, the number and size of vendors can automatically be evaluated by FaDOM. Table 3 shows the number of vendors for the considered marketplaces.

For AppExchange three vendors can be identified which are obviously connected to salesforce.com by name ("salesforce.com", "Salesforce.com Foundation", and Force.com Labs"). On Apps Marketplace two vendors are linked to the marketplace provider by name ("Google Labs" and "Google, Inc."). For SugarExchange and SuiteApp.com one connected vendor is identified respectively ("SugarCRM" and "NetSuite.org"). In the following, all these vendors will be called "internal vendors". In the case of Pinpoint, no vendor linked by name could be identified. Note that it may be possible to identify additional internal vendors by investigations such as capital interlocking analyses.

	AppExchange	Apps Marketplace	Pinpoint	SugarExchange	SuiteApp.com
Number of vendors	500	592	1112	62	82
Thereof internal vendors	3	2		1	1

Table 3: Number of vendors

The composition of a marketplace is also determined by the size of the vendors. Table 4 shows the number of vendors classified by the number of applications offered and the overall number of applications per marketplace. For instance, there are 370 vendors providing one application on AppExchange. 74 vendors offer two Applications. It is obvious that the lion's share of vendors (74.0 %) provides only one application on AppExchange. This result also holds for Apps Marketplace (84.6 %), Pinpoint (86.7 %), SugarExchange (80.6 %) and SuiteApp.com (75.6 %).

		Number of …															appli-cations (total)	appli-cations (by 3rd party)
		applications per vendor																
		1	2	3	4	5	6	7	8	9	10	11	14	18	26	228		
Number of Vendors	AppExchange	370	74	27	9	11	2		2	2	1	1				1	985	742
	Apps Marketplace	501	51	17	6	7	6		1	2					1		801	789
	Pinpoint	964	101	25	10	7	2	1			1			1			1363	1363
	SugarExchange	50	7	2	1		2										86	85
	SuiteApp.com	62	5	5	3	1	1		1	1	2		1				161	160

Table 4: Size of vendors and marketplaces determined by the number of applications offered

The number of applications per vendor shown in Table 4 include the internal vendors as well. It is interesting to note that the number of applications offered by those vendors varies widely. Whereas the internal vendors on SugarExchange or SuiteApp.com just provide one application, the two internal vendors on Apps Marketplace offer three respectively nine applications. An even larger range of internal applications is offered by the three internal vendors on AppExchange. Whereas two internal vendors offer five respectively ten applications, the third one provides 228 applications.

4.2 Stability

Using the application specific metadata by FaDOM over time, not only the static composition of the marketplaces (cf. section 4.1) can be analyzed. In this section we will examine the stability of the SECOs, consisting amongst others of number of vendors, size of vendors and persistence of the vendor structure over time (cf. section 2).
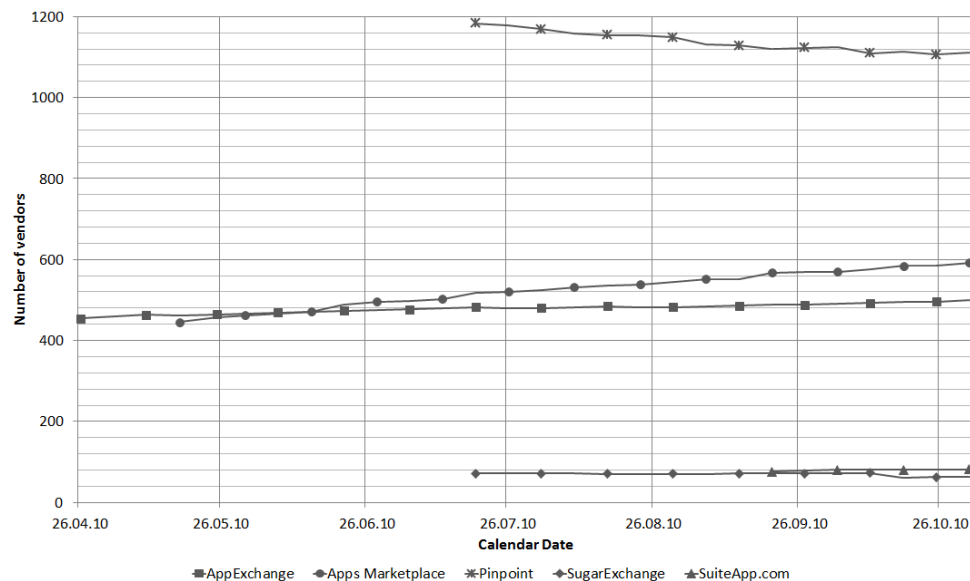

Figure 2: Number of vendors over time

Figure 2 shows the number of vendors over time for the considered marketplaces. Due to the different calendar dates of the first investigation (cf. Table 2), the curves are starting at different points in time. 454 vendors offered applications on AppExchange in late April, 500 on November 1st, 2010. On Apps Marketplace 445 vendors provided applications in mid-May, 592 on November 1st, 2010. Thus, both marketplaces grew measured in terms of vendors in the period under review, whereas Apps Marketplace expanded even more. SuiteApp.com also grew from 76 vendors in mid-September to 82 vendors on November 1st, 2010. In mid-July SugarExchange consisted of 71 vendors. On November 1st, 2010 only 62 vendors provide applications. This negative difference is caused by a disappearance of applications between October 11th and 18th. On October 11th 73 vendors still offered applications on SugarExchange. On Pinpoint, 1185 vendors provided applications in mid-July. However, there are only 1112 vendors left on November 1st, 2010. It can be derived that differences between the marketplaces exist concerning the development of the number of vendors.

The number of applications on the marketplaces is closely linked to the number of vendors and is shown in Figure 3. First of all, it is important to note that the timeline in Figure 3 starts in 2005, whereas our data collection did start mid-April 2010. This is a result of metadata available on AppExchange and SuiteApp.com which declares the date of publication for every application. It is important to emphasize that all applications

which were only provided until the first investigation by FaDOM are not listed in Figure 3. The vertical, black lines mark the date of the first investigation by FaDOM. Until then, the curves are monotonically increasing.
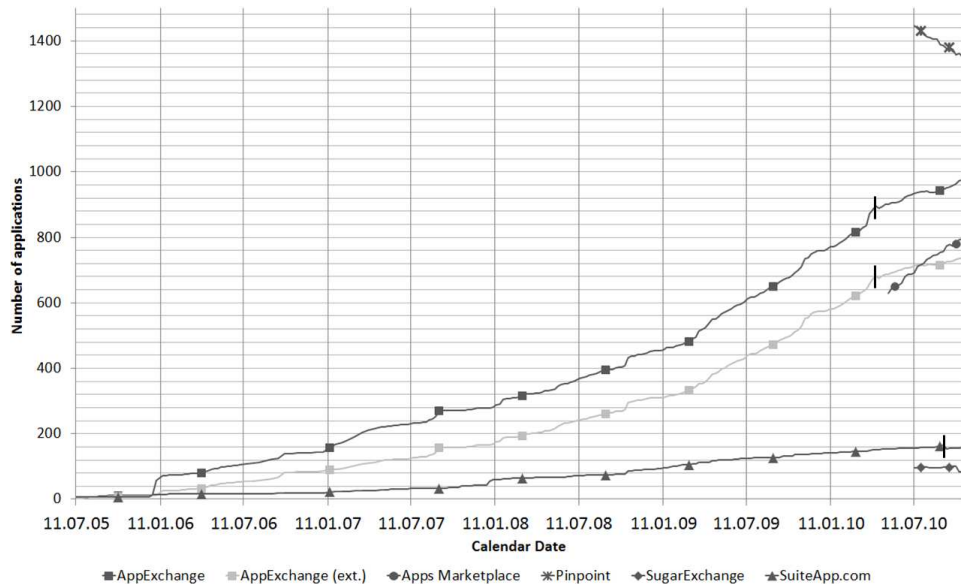

Figure 3: Number of applications over time

Two interesting aspects of the development of AppExchange measured by number of applications may be highlighted. Whereas the black curve marked by squares starting in 2006 shows the overall number of applications on AppExchange, the grey one marked by squares shows the applications by 3rd party vendors only. First, it is easy to see how the curves diverge immediately at the beginning of 2006, which is the start of the AppExchange marketplace. This may have been a strategy to attract customers by internal applications in an initial step. Hereafter, the next step would have been to attract 3rd party vendors by the existing customers [KS94]. Second, the repetitive, rapid increases of available applications are easy to recognize. They may cohere with the repetitive releases of new major code releases of salesforce.com (e.g., so called summer or winter edition) and consequentially may be an indication for the interrelation of extended code releases and the increase of available applications [IL04c].

Finally, we exemplify the persistence of the vendor structure over time on Apps Marketplace and AppExchange. Figure 4 shows the number of applications per vendor on Apps Marketplace and AppExchange over time. First of all, it is obvious that the overall structure has remained unaltered over time, i.e. a lion's share of vendors has offered one application (cf. section 4.1). Nevertheless, the portion of vendors offering one application grew over time. 81.8 % of all vendors offered one application on Apps Marketplace in mid-May, 84.6 % on November 1st, 2010. On AppExchange the portion varied only little from 73.9 % over time. This may indicate that Apps Marketplace is growing by new vendors, whereas AppExchange is growing by a composition of new vendors (with new applications) and already existing vendors with new applications, i.e.

the portion of vendors offering only one application remains constant over time. An example of existing vendors offering new applications may be found in the first investigations of AppExchange. Whereas the very first investigation showed two vendors offering nine or ten applications, the fifth investigation showed both vendors offering eleven applications (cf. right part of Figure 4).
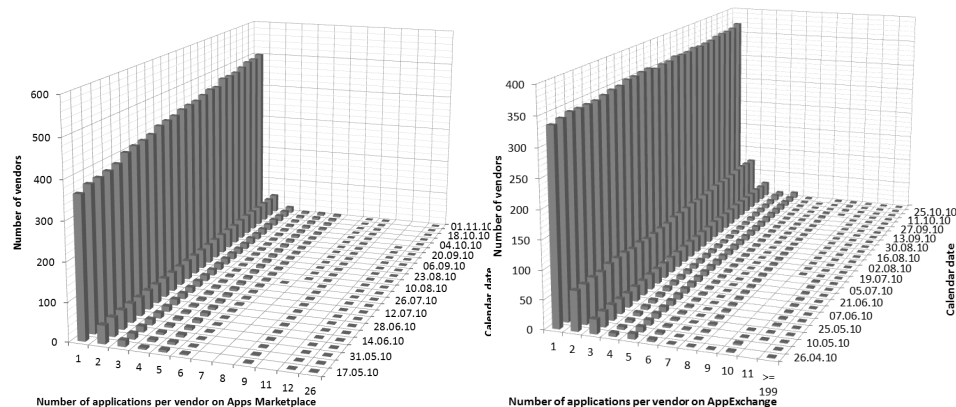

Figure 4: Number of applications per vendor on Apps Marketplace and AppExchange over time

4.3 Pricing

Besides the composition of vendors and stability, the metadata collected by FaDOM allows to analyze the pricing of applications. In case of the considered marketplaces, an automatic distinction between free and paid applications is possible for three marketplaces. On AppExchange 493 applications are subject to a charge, 492 are for free. Those applications include four internal applications which are liable for costs, whereas the remaining 258 internal applications are for free. On Pinpoint only seven applications are for free. 1356 applications are subject to a charge. On SugarExchange 24 applications are for free and 57 are liable for costs. No information is given for twelve applications. It is necessary to note that one application may contain multiple pricing data on SugarExchange due to multiple versions. For Apps Marketplace and NetSuite an automated analysis is not possible since the pricing information is just a free text field. Therefore, we currently conduct a manual study in which we analyze the pricing models applied by the 3rd party vendors in detail (e.g., price metrics).

4.4 Multi-homing

So far, the five considered marketplaces have been analyzed separately. The examination of vendor-sided multi-homing (cf. section 2) is one way of addressing the connectivity between the marketplaces. Figure 5 shows the vendor-sided multi-homing. The squares represent the marketplaces and the circles illustrate the vendors. The size of a circle represents the overall number of applications offered by a vendor, whereas the smallest circles represent vendors offering one application. If a vendor offers at least one

application on a marketplace, the vendor and the marketplace are connected by a dashed line. Note that the distance between vendor and marketplace in Figure 5 has no meaning.

First of all, it is interesting to note that every marketplace is connected to all the other marketplaces. Second, a lion's share of the multi-homing vendors provides applications on two marketplaces (61 vendors). Six vendors offer applications on three marketplaces. Only three vendors provide applications on four marketplaces. In total there are 70 multi-homing vendors. Furthermore one notes that the connection by multi-homing vendors is above average for AppExchange and SuiteApp.com. One reason may be the integration of the CRM solution respectively the smaller solution with complementary solutions.
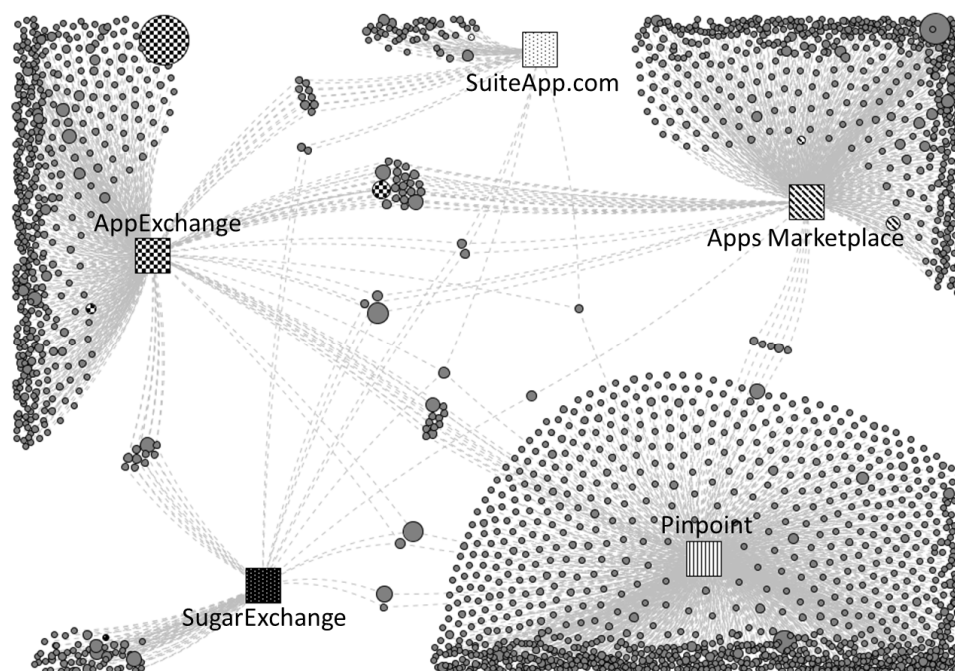
Figure 5: Vendor-sided multi-homing

5 Discussion and Outlook

In this article, we derived several vendor-sided characteristics of SECOs from the respective literature. Since most of those characteristics have not yet been analyzed, we presented FaDOM to gather the publicly available and automatically collectable vendor-sided characteristics of SECOs. Furthermore, we introduced first analyses and visualizations of our empirical data set.

One limitation of our contribution is the interpretation of the data: Since currently no theoretical frameworks regarding the development of software ecosystems exist, our

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interpretations may just represent one of a number of possible perceptions. Thus, a next step should be the adoption of fundamental theories like, e.g., the theory of network externalities to our data set. Furthermore, our analyses are limited by the public available data. For example, missing usage or revenue data avoids the comparison of successful and unsuccessful applications or entire ecosystems. Another interesting avenue for further research may be the in-depth analysis of growth strategies of niche players. This would allow to answer questions like: In which cases is it more promising to provide applications for different platforms than to offer various applications on a specific platform? In this regard, one possible approach may be the comprehension of ecosystem or application providers by, e.g., first-hand surveys.

By means of FaDOM, we conduct a long term longitudinal study about the development of vendor-sided characteristics of different marketplaces and the effects of changes in the strategic concepts of marketplace providers on the SECO characteristics. Additionally, we want to use the collected data as foundation of a qualitative survey in order to examine the entry decision of application providers depending on different design alternatives of the underlying marketplaces.

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